BRANCH OF MINERAL CLASSIFICATION

HANDBOOK

OF

INSTRUCTIONS

Procedures for the

Classification of

Public Lands

(Prepared for Administrative Use)

Conservation Division
U. S. Geological Survey
Washington, D.C.: 1960

HANDBOOK
BRANCH OF MINERAL CLASSIFICATION
U. S. GEOLOGICAL SURVEY

July 1, 1960

Contents

(Prepared for Administrative Use)

Book No. 45

Illustrations

PREFACE

This handbook of instruction for field geologists of the Branch of Mineral Classification, Conservation Division, has been prepared with the object of effecting uniform methods of land classification to provide an appropriate basis for leasing and development of the minerals specified in the Act of February 25, 1920 (41 Stat. 437), as amended.

The application of uniform methods of land classification represents an essential step in the proper administration of the large areas of public land in the western states and Alaska that contain deposits of leasable minerals. To this end, adequate information should be obtained by the geologist relative to the mineral (coal, phosphate, oil and gas, oil shale, potassium, and sodium) involved in the lands that are under consideration in any instance. Furthermore, the township map and report relative to the lands that he submits subsequently to the Washington office should present the data required for classification so that they conform with approved classification standards.

This handbook is not intended to be a manual of surveying instructions or of map-making techniques. It is designed mainly to acquaint the geologist with the methods of mineral land classification, and with the various requirements under applicable laws and regulations, so that he may become familiar with the numerous details of relating his field work to classification procedures.

Comprehensive knowledge of the administrative details involved is necessary to assure action consistent with law and geologic fact. It is not intended that these instruction will cover every detail; the geologist is expected to exercise a reasonable amount of discretion in connection with his task of classifying the public lands.

A book of forms has been compiled as a guide in the preparation of replies in the Washington office to requests from various agencies concerning the mineral character of land. Samples of routine replies and copies of form letters comprise the major part of the compilation, but it also contains sample letters relative to transmittal of formal classifications to the Director, Bureau of Land Management and to the Federal Register; these letters supplement the discussion of such letters in Chapter V. of this volume.

A review of the history and legal basis for land classification is contained in USGS Bulletin 537 (1913) and should be consulted for further details. The Division files and various publications listed in the bibliography will also furnish much pertinent information. Some material issued previously that has not been changed to a marked extent is presented herein single-spaced; all other material is double spaced. Much material has been obtained from Branch files and from memoranda on land classification by former and present employees of the Branch, both in Washington and in the field. Information obtained as a result of field conferences of supervisory personnel has also been included. Chapter II, on "Base Maps and Materials," was taken, in large part,

from the Technical Workbook, Part I, Geologic Map Compilation, by the Fuels Branch, U. S. Geological Survey, Albuquerque, New Mexico, pages 2 to 23 inclusive. The section on map compilation in Chapter III, mainly on the use of photogrammetric aids, has been extracted from a text, "Photogrammetric aids and compilation procedures for geologists," prepared by the Committee on Photogrammetric Techniques in Geology, Topographic Division and Geologic Division, U. S. Geological Survey (1956). A memorandum, dated February 14, 1956, from the Chief Geologist, Geologic Division, to all professional and supervisory personnel, on the subject: "Geologic maps: classification, definitions, and standards," is quoted in the discussion on mapping. The procedures for the sampling and description of coal beds (in the appendices) were taken from the "Guide for the field description of coal beds" by James M. Schopf of the Geological Survey (1950), as revised. The discussion about known geologic structures was abstracted from an unpublished paper by the late John D. Northrop, former Assistant Chief of the Conservation Division and Chief of the Mineral Classification Branch.

Particular thanks are due H. G. Keiser for editing the manuscript and to George W. Brett for his many suggestions and contributions to the text. Thanks are also due Harold J. Duncan, Chief of the Conservation Division, for critical review of the manuscript and for suggestions regarding its presentation. In addition, the following persons supplied memoranda that have aided materially in the preparation of the manual: Andrew F.

Bateman, Charles E. Erdmann, Emmett A. Finley, Alice E. French, Willard C Gere, George H. Horn, W. G. Hoyt, Arthur Johnson, William B. Kramer, E. E. Richardson, M. B. Smith, Joseph D. Turner, Russell G. Wayland, Phyllis S. Wilson.

J. C. Miller
Chief, Branch of Mineral Classification

CHAPTER I

CHAPTER I -- INTRODUCTION

ORGANIZATION AND FUNCTIONS

Geological Survey

General

The organic Act of March 3, 1879 (20 Stat. 377, 394), establishing the office of Director of the Geological Survey, provided that:

" . . . This officer shall have the direction of the Geological Survey, and the classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain. And that the Director and members of the Geological Survey shall have no personal or private interests in the lands or mineral wealth of the region under survey and shall execute no surveys or examinations for private parties or corporations. . ."

An excellent paper on the history of the Geological Survey has been prepared by John C. and Mary C Rabbitt (1954) and should be referred to for additional background.

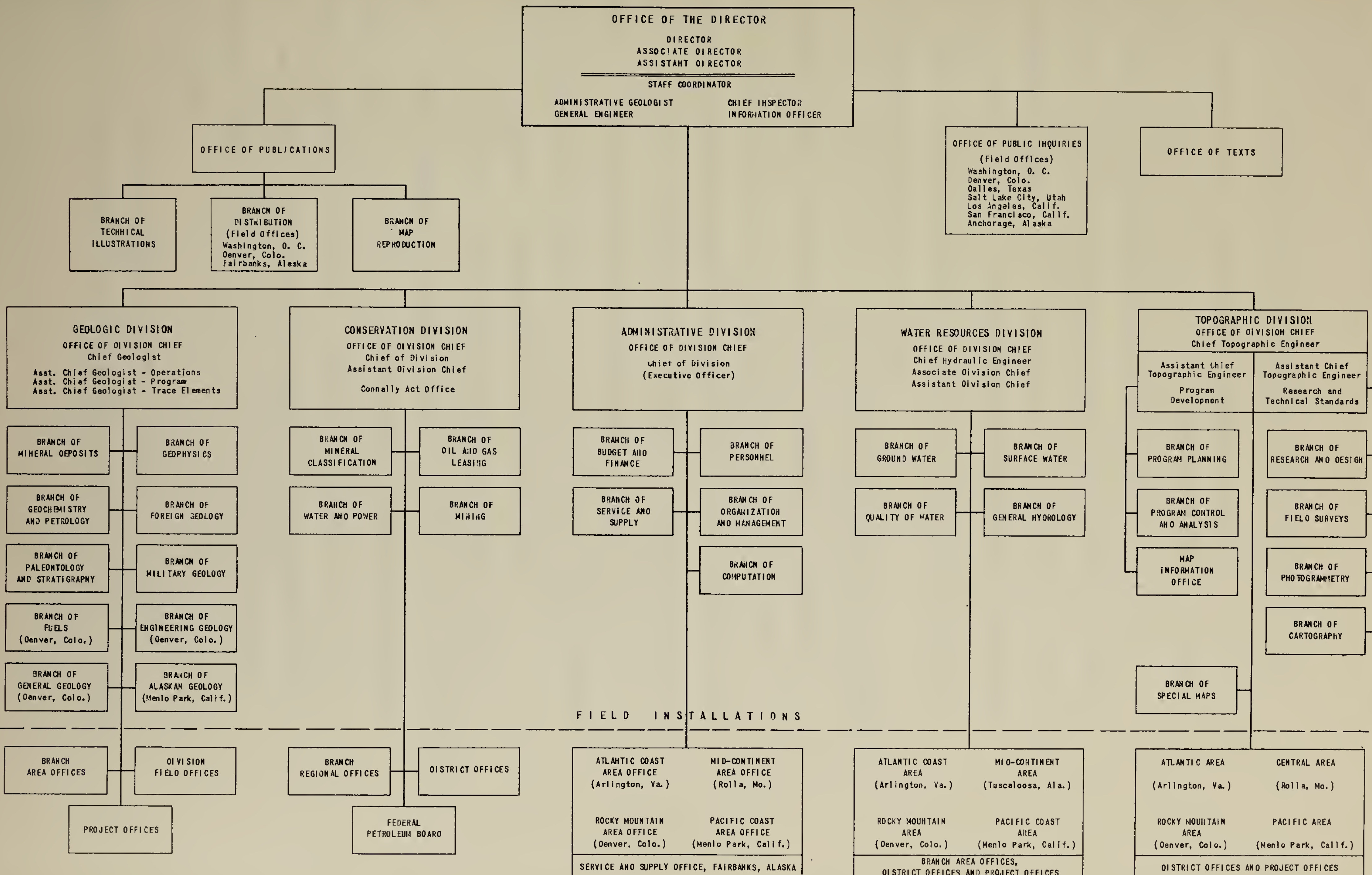
The Geological Survey performs surveys, investigations, and research covering topography, geology, and the mineral resources and water resources of the United States and its Territories; classifies land as to mineral character and water and power resources; gives engineering supervision to power permits and Federal Power Commission licenses; enforces Departmental regulations applicable to oil, gas, and other mining leases, permits, licenses, and operating contracts; and publishes and disseminates data relative to the foregoing activities (see figure 1). More specifically, the Survey does the following:

July 1, 1958

Approved: Thomas B. Nolan, Director

ORGANIZATION OF THE GEOLOGICAL SURVEY
DEPARTMENT OF THE INTERIOR

FIGURE 1



40799

1. Classifies Federal land as to water storage, water power, and mineral value; supervises operations on mining and oil and gas leases on Federal and Indian land; promotes safety and welfare of workmen; maintains production accounts and collects royalties; prepares maps and reports for publication; and provides the Bureau of Land Management and other Federal agencies geologic and engineering advice and services in the management and disposition of the public domain. The Survey also administers the activities of the Federal Petroleum Board under the Connally Act.

2. Makes geologic surveys and investigations to determine and appraise mineral and mineral fuels resources, to determine geologic structure; and to provide geologic guidance for land utilization problems; conducts research to develop, interpret, and understand geologic principles and processes; develops techniques, concepts, and instrumentation for prospecting; collates and synthesizes geologic information on mineral and mineral fuel resources; and prepares results of investigation for publication.

3. Prepares and publishes topographic maps; conducts research in the component fields of control surveys, aerial photography, and cartography, covering both the techniques and instrumentation involved in mapping operations; reviews the adequacy of existing maps to meet current needs; systematically revises existing maps to maintain their usefulness and prepares the results of mapping for publication.

4. Collects, analyses, and interprets hydrologic and geologic data relating to water resources; evaluates water resources

of specific areas and determines water requirements for industrial, domestic, and agricultural uses; performs research and development to improve the scientific basis of investigations and techniques; publishes the results of these investigations; and provides scientific and technical assistance in hydrologic fields to other Federal agencies.

Cooperation. -- In announcing on January 16, 1959, a policy of cooperation with States, counties, and municipalities, Director Nolan stated, in part, that:

"The functions of the U. S. Geological Survey based on Acts of Congress and on tradition, are national in scope. . . . (See Survey Manual 500.1.1)

"A variety of State agencies (including counties and municipalities) carry on some of the same functions as the Survey. To the extent that the States do these things, national objectives are furthered, but this does not relieve the U. S. Geological Survey of its national responsibilities. . . ." (See Survey Manual 500.1.2)

The Conservation Division, as a rule, will not be called on to enter into any cooperative agreement with a State, county, or municipality for mapping or for other purposes associated with administration of the public domain. In this connection, it is well to keep in mind the following quotation from the Director's statement:

"It is Survey policy not to duplicate programs or projects carried on by the States, but to apply its effort to investigations or activities which: (a) as a whole provide at any given time reasonable balance in knowledge, data, or coverage of the whole field, geographically

or in subject matter; (b) States or local groups do not undertake, or do not assign the priority dictated by national need; and (c) are needed to meet Federal requirements that may be of little or no concern to the States." (See Survey Manual 500.1.3C)

Coordination of Functions of the Geological Survey and the Bureau of Mines

Memorandum No. 3 of the Minerals Committee, dated July 31, 1946, is a report to the Coordinating Committee, then existing but now called the General Staff Committee, on the conflict of functions and duplication of activities of the Geological Survey and the Bureau of Mines. In September 1946 the two Bureau Directors, in a memorandum for the Under Secretary, jointly reported their proposals for conforming with the recommendations of said committee. Among the recommendations of the Minerals Committee endorsed by the Bureaus were the following:

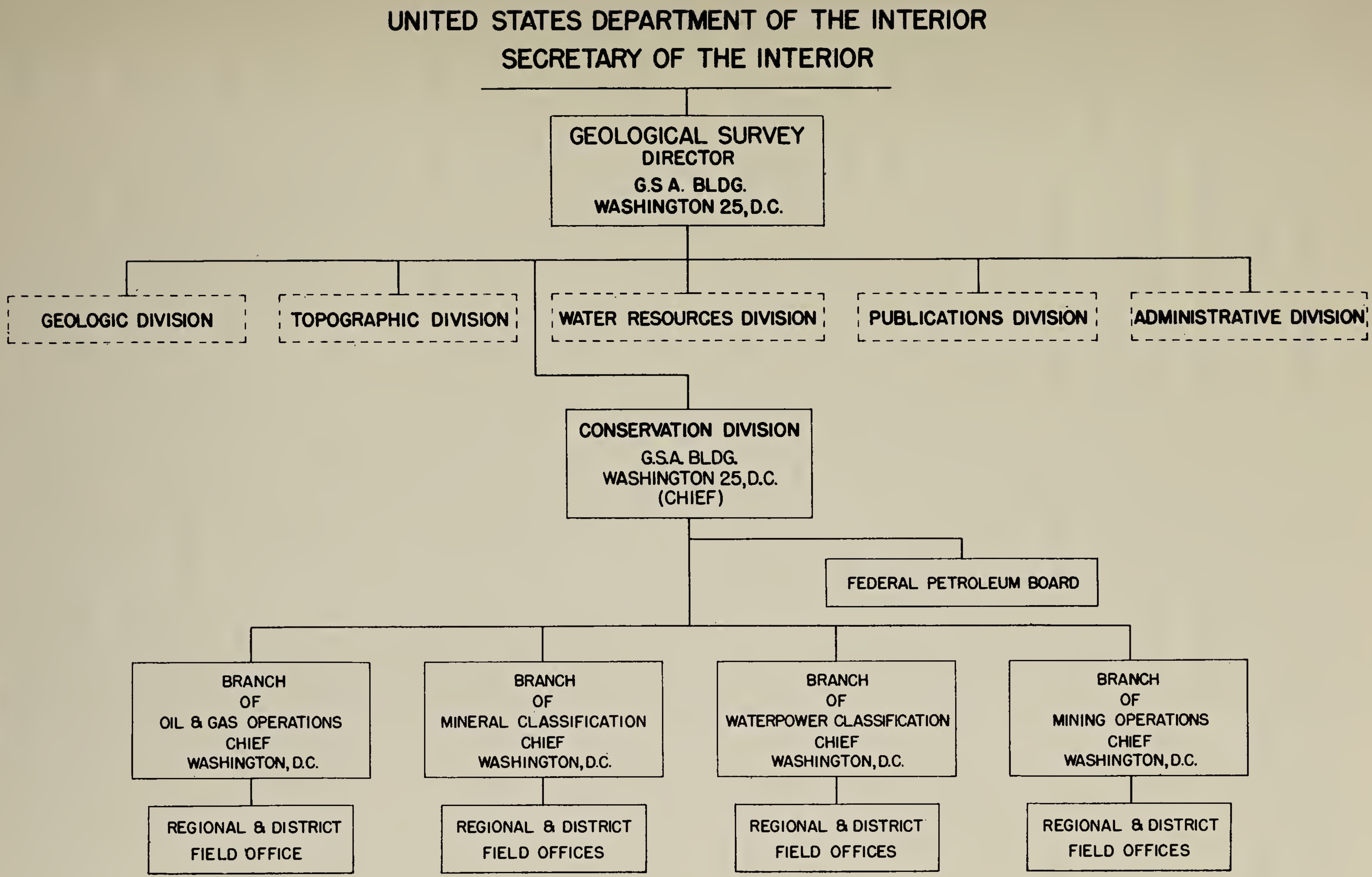
> "The function of mining and its sub-functions of development, production, and conservation . . . clearly belong in the province of the Bureau of Mines. Prospecting has two sub-functions, exploration and evaluation. The sub-function of exploration, which leads to the discovery of a mineral deposit seems beyond question to lie within the province of the Geological Survey. The sub-function of evaluation . . . which leads to the determination of the extent of the mineral deposit and of the quantity and approximate grade of the mineral in place, is the area in which overlapping activities have principally occurred. This sub-function has been thoroughly studied to determine if there exists within it any satisfactory line of cleavage whereby it could be divided and the parts assigned respectively to the two bureaus. The Committee considers that this sub-function cannot be so divided and that it must be, therefore, assigned in its entirety to one of the agencies concerned. It is the opinion of the Minerals Committee that the evaluation of a mineral deposit, as herein defined, belongs with prospecting rather than with mining and is accomplished primarily by the use of geological techniques. It therefore belongs in the province of the Geological Survey . . .

"Evaluation is the determination of the probable value of the mineral deposit. As herein used, it consists in the determination of the mode of occurrence, attitude, extent, and approximate grade of the mineral deposit and the estimation of the quantity of the mineral in place that the deposit contains. Evaluation necessarily requires the determination of the extent of the deposit in three dimensions and may, therefore, require the digging of pits and the drilling of holes to intersect the deposit beneath the surface to determine its depth and thickness and to procure samples. . . .

"The Bureau of Mines will, with reference to development, be concerned with . . . determining the quality and mineable quantity . . . and the possibility of basing a mining enterprise upon it. . . ."

Conservation Division

The Conservation Division (formerly Conservation Branch) under the Director, United States Geological Survey, was organized July 1, 1925. It has two primary functions. These two functions, carried out by four organizational branches (figure 2), are (1) the classification of federally-owned or controlled lands as to their mineral character and as to their value for water power and storage purposes, and (2) the supervision of operations incident to prospecting, development, and production of minerals on Federal, Indian, and Naval petroleum reserve lands, and submerged lands on the outer Continental Shelf, under Federal lease, license, and prospecting permits. Both functions are concerned with the discovery, efficient development, and prudent use of mineral and water resources belonging to the United States, and neither function is performed by any other government agency. On February 14, 1958, by Departmental Order 2828, administration of the Connally Act of February 22, 1935, was transferred to the Geological Survey On February 28, 1958, the Director delegated the immediate responsibility for the administration of these functions and for the supervision of the operations of the Federal Petroleum



ORGANIZATION CHART CONSERVATION DIVISION

Location of all field offices and areas administered are shown on the following pages and maps.
Address communications to director or heads of offices concerned as provided in laws, regulations and instructions.

Figure 2

Board to the Chief, Conservation Division. The Departmental Manual, Organization Series, Part 120, Geological Survey, Chapter 3, gives further details on the organization of the Division.

The first-named function, land classification, carried out by the Branch of Mineral Classification and the Branch of Waterpower Classification, is performed pursuant to the provisions of the Act of March 3, 1879 (20 Stat. 377), which created the Geological Survey and charged its Director with the responsibility of classifying the public lands of the United States. The major part of the public domain is in the states west of the 100th meridian, and most of the classification work of the Branch of Mineral Classification is directed toward effecting various provisions of the Act of February 25, 1920 (41 Stat. 437), and amendments thereto. With the exception of duties under the Connally Act, the second-named function, carried out by the Branch of Oil and Gas Operations and the Branch of Mining Operations, is performed in accordance with the provisions of the various mineral leasing laws, and applicable regulations thereunder, under authority delegated from the Secretary of the Interior.

The duties of the Conservation Division, in addition to those required of the Survey by the Act of March 3, 1879 (supra), have been increased by various leasing acts and amendments thereto, and delegations of authority from the Secretary applicable to public domain, acquired, and Indian lands. The regulations under these acts are given in the Code of Federal Regulations, Title 43, Public Lands; Title 25, Chapter I, Subchapter R, Indian Lands; and Title 30,

Mineral Resources. These various actions relating to mineral leasing of Federal lands, have their origin in some of the more important laws. All of these in the following list are not discussed in the text, but have added materially to the work of the Division:

- March 3, 1883 (22 Stat. 487) Coal lands in Alabama withheld from homesteading.
- March 27, 1906 (34 Stat. 88) Authorized Secretary to reclassify public lands.
- June 25, 1910 (36 Stat. 847) Withdrawals of public land.
- April 23, 1912 (37 Stat. 90) Extended Act of June 22, 1910 to include coal lands in Alabama.
  - August 24, 1912 (37 Stat. 497) Permitting metalliferous mining claims on withdrawn lands.
  - July 17, 1914 (38 Stat. 509) Agricultural entry on some nonmetalliferous mineral lands.
- October 2, 1917 (40 Stat. 297) Exploration and disposition of potassium lands.
- February 25, 1920 (41 Stat. 437) Mineral Leasing Act, as amended by:
  - April 17, 1926 (44 Stat. 301) Leasing sulphur in Louisiana and New Mexico.
  - February 7, 1927 (44 Stat. 1057) Potassium permits and leases.
  - May 21, 1930 (46 Stat. 373) Secretary to lease oil and gas to owner or assignee, land under railroad or other rights of way.
  - March 4, 1931 (46 Stat. 1523) Unit or cooperative plan of development.
  - May 7, 1932 (47 Stat. 151) Amended Act of February 7, 1927, to allow two-year extensions of permits.
  - March 3, 1933 (47 Stat. 1487) Minerals in Anza State Park, California.
  - August 2, 1935 (49 Stat. 674) Oil and Gas Leasing, termination of permits.
  - October 3, 1944 (58 Stat. 765) Surplus property.
  - August 8, 1946 (60 Stat. 950) Productive limits, royalty benefits.
- May 23, 1930 (46 Stat 377) Extended provisions of Sec. 2455. Revised statutes to coal lands in Alabama.
- May 16, 1946 (60 Stat.1099) Sec. 402, Reorganization Plan No. 3 of 1946. Creation of Bureau of Land Management.
- July 31, 1947 (61 Stat. 681) Materials Act.
- August 7, 1947 (61 Stat. 913) Leasable Minerals on acquired lands.
- September 1, 1949 (63 Stat. 683) Authorized leasing and disposal of minerals in lands in Shasta National Forest.
- June 30, 1950 (64 Stat. 311) Leasing minerals in Superior National Forest.
- August 7, 1953 (67 Stat. 464) Outer Continental Shelf Lands Act.

August 13, 1954 (68 Stat. 708) Multiple-use Act - also mining claims and fissionable materials.

July 23, 1955 (69 Stat. 367) Amendment, Materials Act, and mining laws.

August 11, 1955 (69 Stat. 679) Source material - coal land.

August 11, 1955 (69 Stat. 681) Mining Claims Rights Restoration Act (opening of power withdrawals and reservations).

August 27, 1958 (72 Stat. 928) State indemnity selections.

Branch of Mineral Classification

Old Land Classification Board Activities. -- The predecessor of the Branch of Mineral Classification was the Land Classification Board, and some of the practices initiated by that Board still survive; for example, the preparation of minutes of the Oil Board, and minutes covering the formal classification of lands for coal and other leasable minerals.

The land classification work had its beginning in 1906 when, by cooperative agreement between the Survey and the General Land Office, now the Bureau of Land Management, arrangement was made for the Survey to be chiefly responsible for physical classifications of the land, and to report its findings to the General Land Office.

The Land Classification Board was organized as a section of the Geologic Branch (now Division) by order of the Director on December 18, 1908. A. C. Veatch was in charge until November 7, 1910. After Veatch's resignation, the section was placed in charge of W. C. Mendenhall on January 1, 1911. By Survey Order No. 10 of May 1, 1912, the Land Classification Board was given the rank of a branch similar to the Geologic, Topographic, and Water Resources Branches. The official name, Land Classification Board, was retained: ". . . as but expressing the combination of quasi-judicial and administrative functions of the branch." The newly organized branch contained two

divisions: Division of Mineral Classification, and Division of Hydrographic Classification. W. C. Mendenhall was designated Chief of Board; N. C. Grover, Chief Engineer; and Elsie Patterson, Secretary.

The Division of Mineral Classification was composed of the following members:

W. C. Mendenhall, Geologist in Charge
Coal Section, George Ashley, Chairman
Oil Section, M. W. Ball, Chairman
Phosphate Section, A. R Schultz, Chairman
Metalliferous Section, A. R. Schultz, Chairman

The Division of Hydrographic Classification was composed of the following members:

N. C. Grover, Chief Engineer, in charge
Water Power Section, W. B. Heroy, Chairman
Irrigation Section, Herman Stabler, Chairman

Some of the functions of the newly organized branch, as described in Survey Order No. 10, follow:

"It shall be the duty of the Land Classification Board to consider questions of Survey policy in matters relating to classification and to report its recommendation to the Director . . . and to receive, record, and make available in the administration of the public lands all data valuable for purposes of land classification that have been or may be secured by the other branches. . . .

"In the performance of these functions the Land Classification Board will specify its requirements in the character of the classification data to be submitted and will effect and formulate the actual classifications on the basis of the data supplied to it by the field branches . . . ."

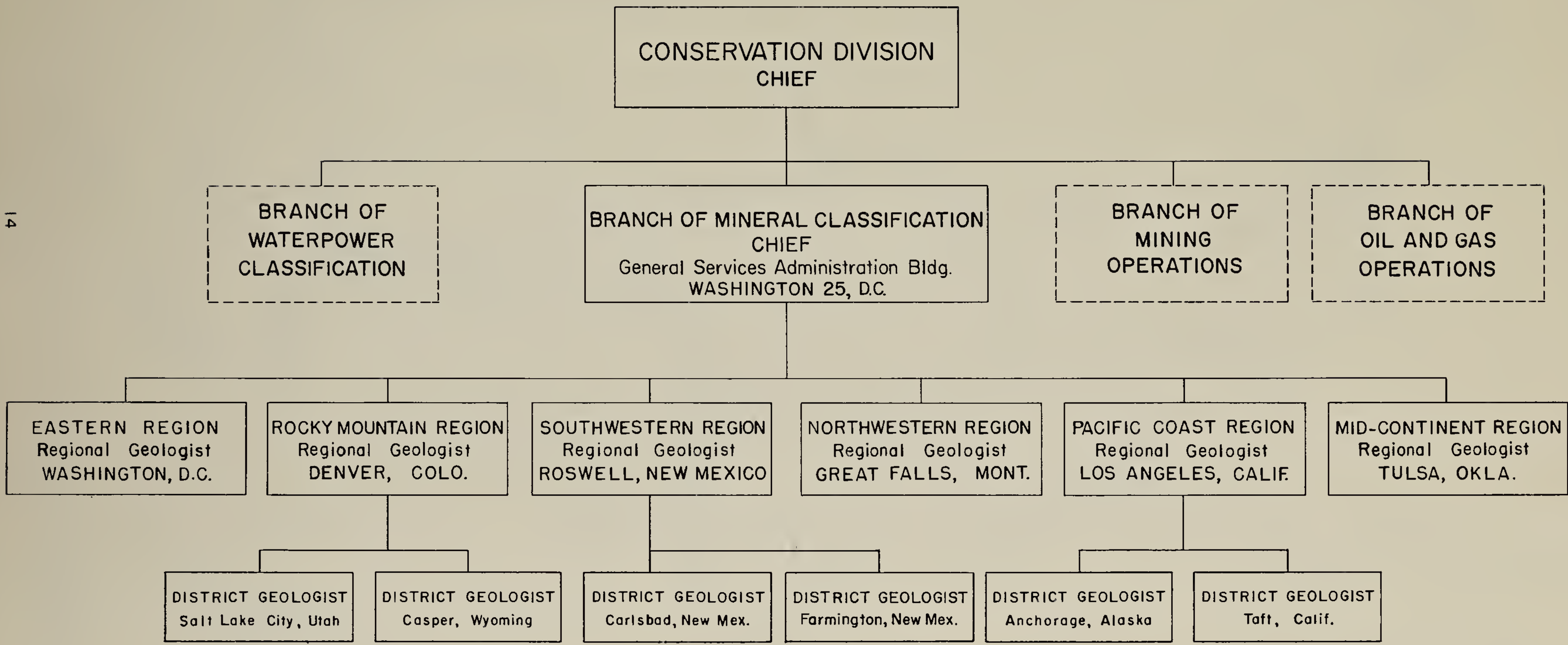
Survey Order No. 115, dated July 1, 1925, created the Conservation Branch (now Division) and provided that:

"The Conservation Branch will continue the functions of the former Land Classification Board, together with the mineral leasing activities transferred today from the Bureau of Mines."

The record is silent on the origin of the manner of keeping the proceedings of actions taken before July 1, 1925, but apparently a determination was made that a formal record of each action should be kept in the form of minutes. These records were prepared on legal-size paper following a meeting of the several members constituting any one section or board. In this manner, minutes were prepared for the Coal Board, the Phosphate Board, and for the other mineral boards involved in formal classification. Although the several "boards" no longer sit in executive session, the geologic background and reasons for the mineral and nonmineral classifications are recorded in "Minutes of the ________ Board," to formalize such actions or determinations. These formal classifications are then shown on township plats signed by the Director pursuant to the mandates of applicable legislation and regulations.

Present Branch Activities.-- The Branch of Mineral Classification, as now constituted, is organized along regional lines, as shown in figure 3, with overall administration by the Branch headquarters office in Washington, D. C. Figure 4 shows the six regions comprising the Branch, the headquarters of each region, and the several sub-offices that administer certain areas for closer on-the-spot investigations and control.

ORGANIZATION CHART
BRANCH OF MINERAL CLASSIFICATION
CONSERVATION DIVISION
GEOLOGICAL SURVEY



UNITED STATES
DEPARTMENT OF THE INTERIOR

Figure 3

JULY 1960

U.S. DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY CONSERVATION DIVISION

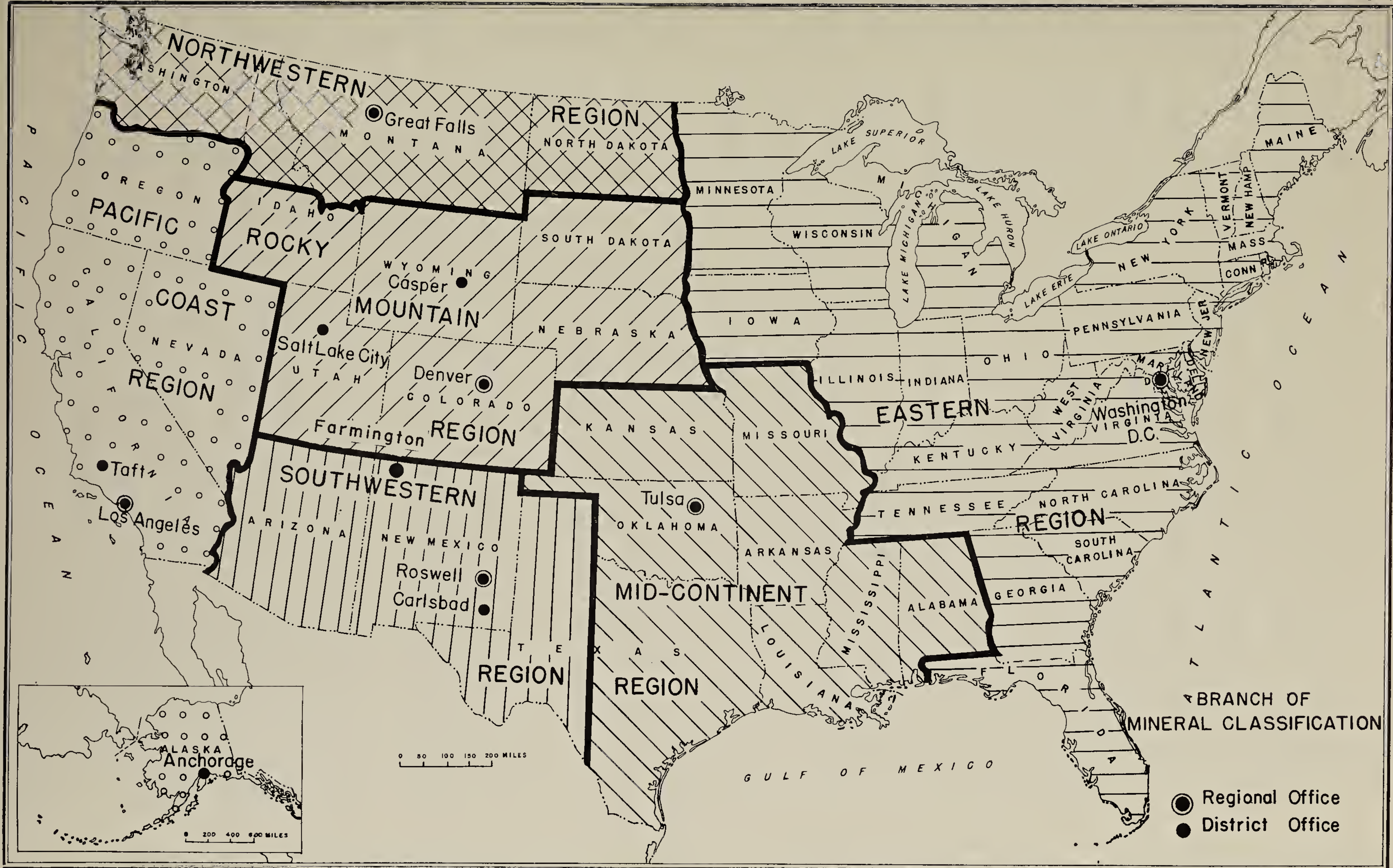


Figure 4 — Map showing Branch regions and offices

The primary objectives of the Branch are (1) determination, from pertinent geological data and evidence, of the actual or probable presence of leasable minerals and other mineral deposits of value in specific tracts or parcels of public and acquired land anywhere in the United States or its territories; (2) protection of such public land mineral estates of leasable minerals, by timely notice, withdrawals, or classification, from unrestricted disposal under nonmineral land laws; (3) promotion of the exploration and development of such estates under applicable provisions of the Federal mining or mineral-leasing laws; (4) furnishing promptly, to the administrative and supervising agencies involved, the geologic determinations and counsel requisite to the effective discharge of their responsibilities.

In furtherance of these objectives, the Branch determines the land area to be formally withdrawn for purposes of mineral investigation and, subsequently, classifies the lands as being mineral or non-mineral in character and initiates orders for restoration or release of such lands from withdrawals.

The Mineral Leasing Act of 1920 (as amended by the Act approved August 8, 1946) provides for competitive and noncompetitive leasing of federal lands as follows:

"All lands subject to disposition under this Act which are known or believed to contain oil or gas deposits may be leased by the Secretary of the Interior. When the lands to be leased are within any known geologic structure of a producing oil or gas field, they shall be leased to the highest responsible qualified bidder by competitive bidding under general regulations . . .

"When the lands to be leased are not within any geologic structure of a producing oil or gas field, the first person making application for the lease who is qualified to hold a lease under this Act shall be entitled to a lease of such lands without competitive bidding."

The Branch determines whether an application for an oil or gas lease contains lands on a known geologic structure of a producing oil or gas field, defined or undefined. If the lands in the application are on a known geologic structure, the land office is notified so that they may take appropriate action.

The Branch is also responsible for reporting to the Bureau of Land Management all first discoveries of oil or gas affecting federal lands. These reports usually list all lands affected by the discovery, and such lands are classified as being within an undefined known geologic structure. The Branch also makes determinations of discoveries of new deposits pursuant to applicable regulations and reports its findings to the Oil and Gas Supervisor in aid of proper royalty accounting.

Prior to the passage of the Mineral Leasing Law of February 25, 1920, however, the right to extract oil and gas from the public domain issued from the Mining Law of May 10, 1872 /(17 Stat. 91) See CFR Parts 185.6, 185.9, 185.11_7, by permitting the staking of placer claims. There was some doubt as to oil and gas being a mineral subject to location and purchase under the Act of May 10, 1872. The Act of February 11, 1897 /(29 Stat. 526), See CFR Part 185.32_7, however, permitted the patenting of lands containing petroleum under the placer mining laws, provided the entries were made prior to the date of this Act. Comparable classification activities are performed involving lands valuable for

coal, oil shale, phosphate, potash, sodium, or sulphur, under the mineral-leasing laws, and for all minerals on acquired lands.

The law under which coal lands were acquired was the Act of March 3, 1873 (17 Stat. 607). It was incorporated in the Revised Statutes as Sections 2347 to 2352, which were superseded by the Act of February 25, 1920. The established policy, in the period following the Act of March 3, 1873, particularly from about 1906 to 1909, was to make coal land withdrawals by Secretarial Order which withheld from acquisition agricultural lands in known coal areas. For a time this worked a great hardship on the agricultural entryman. The situation was relieved by the passage of three acts providing for agricultural entry on lands withdrawn or classified as coal lands. The three acts listed below, which are usually referred to as the "separation Acts," provided, in effect, for the first multiple use of public land.

Act of March 3, 1909 (35 Stat. 644)
Act of June 22, 1910 (36 Stat. 583)
Act of April 30, 1912 (37 Stat. 105)

The Act of March 3, 1909 provides that persons who have entered or selected lands under the nonmineral laws, lands subsequently classified, claimed, or reported as being valuable for coal, may elect to receive patent to these lands by reserving the coal deposits to the United States.

The Act of June 22, 1910 goes a step further and provides that agricultural entries and Carey Act selections may be made on lands withdrawn or classified as coal provided the entryman agrees in advance to a reservation of coal to the United States.

The Act of April 30, 1912 extends the Act of June 22, 1910, to include State selections and isolated tracts.

In Alabama, the Act of March 27, 1906, authorized the Secretary to reclassify public lands to determine which are agricultural and which are mineral lands, and to decide which are subject to homesteading. An Act approved April 23, 1912 (37 Stat. 90) extended the operation of the Act of June 22, 1910 to coal lands in Alabama which were withheld from homesteading under an old law /the Act of March 3, 1883 (22 Stat. 487)_7, excluding the public lands in Alabama from the operation of the laws relating to mineral lands but providing that lands containing coal and iron shall be first offered at public sale. This was changed with the passage of the Act of May 23, 1930 (46 Stat. 377) which extended the provisions of Sec. 2455 Revised Statutes to coal lands in Alabama in regard to isolated tracts.

Until June, 1910, withdrawals of mineral lands were made by the Secretary of the Interior whenever the public interest appeared to be served thereby. The validity of such withdrawals was questioned, and Congress enacted a measure on June 25, 1910 (36 Stat. 847), authorizing the President to make withdrawals in certain cases. Immediately after the passage of that Act, Executive Orders ratifying, confirming, and continuing in full force and effect all outstanding orders of withdrawal were issued by the President. Under this authority about 45 million acres of public domain were withdrawn in the aid of legislation and for classification.

A serious fault existed in the provision in Sec. 2 of the 1910 Act in that withdrawn lands were open to acquisition under the mining laws

so far as they apply to minerals other than coal, oil, gas, and phosphate. Thus, there was no provision for the withdrawal of lands containing other nonmetalliferous minerals. It was therefore possible to locate valuable power sites as building-stone placers, and to include oil lands in placer claims located on worthless deposits of such minerals as gypsum. The passage of the amendatory act of August 24, 1912 (37 Stat. 497), remedied this situation by providing for the location of metalliferous minerals only under the mining laws.

The Act of July 17, 1914 (38 Stat. 509), opened to appropriation, location, selection, entry, or purchase under the nonmineral land laws, all lands withdrawn or classified as phosphate, nitrate, potash, oil, gas, or asphaltic mineral land. The public lands were, therefore, open to surface entry with a mineral reservation, and to location for metalliferous minerals.

The Act of October 2, 1917 (40 Stat. 297), authorized exploration for and disposition of potassium bearing lands. This Act was later repealed by the Act of February 7, 1927, which provided for the issuance of permits and leases for chlorides, sulphates, carbonates, borates, silicates, or nitrates of potassium on the public domain. This act was amended May 7, 1932 (47 Stat. 151) to allow two-year extensions of permits.

The Mineral Leasing Law of February 25, 1920 (41 Stat. 437), provides for the mining of coal, phosphate, oil, gas, oil shale, and sodium on the public domain. A number of amendments have been added since that date.

The Act of April 17, 1926 (44 Stat. 301), as amended by the Act

of July 16, 1932 (47 Stat. 701), authorized the granting of permits and leases on sulphur in Louisiana and New Mexico.

The Act of May 21, 1930 (46 Stat. 373), authorized the Secretary to lease for oil and gas to the owner or his assignee, land under railroad or other rights of way.

Section 402, Reorganization Plan No. 3 of 1946 (60 Stat. 1099) transferred the function of the Secretary of Agriculture and the Department of Agriculture relative to the leasing or other disposal of minerals in certain acquired land to the Secretary of the Interior. Subsequently the Acquired Lands Act of August 7, 1947 (61 Stat 913), provided for disposition of oil, gas, oil shale, coal, phosphate, potassium, sodium, and sulphur on acquired land, under the Mineral Leasing Act of February 25, 1920 (41 Stat. 437), as amended. The Act of September 1, 1949 (63 Stat. 683), authorized leasing and disposal of minerals in certain lands in Shasta National Forest in California; the Act of March 3, 1933 (47 Stat. 1487), of minerals in the Anza State Park of California; and the Act of June 30, 1950 (64 Stat. 311), of minerals in Superior National Forest in Minnesota, except those covered by the Acquired Lands Act of 1947.

The Act of August 7, 1953 (67 Stat. 462), the Outer Continental Shelf Lands Act, authorizes the Secretary to issue on a competitive basis leases for oil, gas, sulphur, and other minerals in submerged lands of the Outer Continental Shelf.

Some of the duties required of Branch geologists are: 1/

(1) field investigations to obtain geologic data needed for the specific determinations constantly required in the discharge of the mineral-classification function; (2) systematic studies of surface and subsurface conditions in order that the efficiency of recovery procedures may be increased in oil and gas fields, and in coal, potash, phosphate, and other mineralized areas under active development; (3) studies in cooperation with the Branch of Waterpower Classification, Conservation Division, of potential dam and reservoir sites and the feasibility of future power projects; (4) determination of the areas that are geologically subject to inclusion in plans of unit operations for oil and gas deposits (these are first reviewed by the Branch of Oil and Gas Operations and are subject to approval by the Director, USGS); (5) determinations for oil and gas leasing by competitive bidding; and (6) determinations, in collaboration with the Branch of Mining Operations, in each application for a lease, license, or prospecting permit for coal, potash, sodium, phosphate, oil shale, or sulphur

---

1/ These duties are also phrased as follows in the Civil Service Commission's Class Specification of June 1948 for the Geology Series (GS 1350): "Geologists (Mineral Classification) by means of areal survey, mapping and geologic examination (using techniques ascribed to other specializations, as required) determine the mineral or nonmineral character of specified parts of the public domain; analyze data collected to determine the relative value of such land for mineral development and the effect of land use on the recovery of minerals; prepare reports expressing geologic findings in forms adapted to the needs of public land law administration; recommend, on the basis of areal surveys, logical development units under mineral leasing laws; and make similar surveys in connection with petroleum and natural gas including definitions of the known geologic structure of producing gas and oil fields, and the geologic review of plans submitted for unit or cooperative operation and development of such fields."

in Federal lands. In addition, all minerals on acquired lands are subject to a determination

A large volume of the work of the Branch, particularly in the Washington office, is performed for other agencies such as the Bureau of Land Management; Department of Health, Education, and Welfare; Department of Defense; Department of Justice; Fish and Wildlife Service; and Bureau of Reclamation. These relations are shown on figure 5. A section of this manual (Section B of Chapter V) is devoted to a discussion of that work in which the Branch acts primarily in a consulting capacity.

In summary, the work of the Branch may be divided into three categories, according to land ownership, as follows:

Public lands.-- The Act of February 25, 1920 (41 Stat. 407), as amended, known as the Mineral Leasing Act, is an act to promote the mining of coal, phosphate, oil, oil shale, gas, sodium, and potassium, and, in some areas, sulfur. It is applicable only to public domain lands and forms the basis for most of the cooperation on land matters between the Bureau of Land Management and the Survey. The correct mapping and classification of these lands aids in leasing operations.

Acquired lands.-- The "Mineral Leasing Act of Acquired Lands," approved August 7, 1947 (61 Stat. 913), was enacted to promote the mining of coal, phosphate, sodium, potassium, oil, oil shale, gas and sulfur on lands acquired by the United States "by foreclosure, or otherwise for resale, or reported as surplus pursuant to the provisions of the Surplus Property Act of October 3,

WORK CHART

Bronch of Minerol Clossificotion

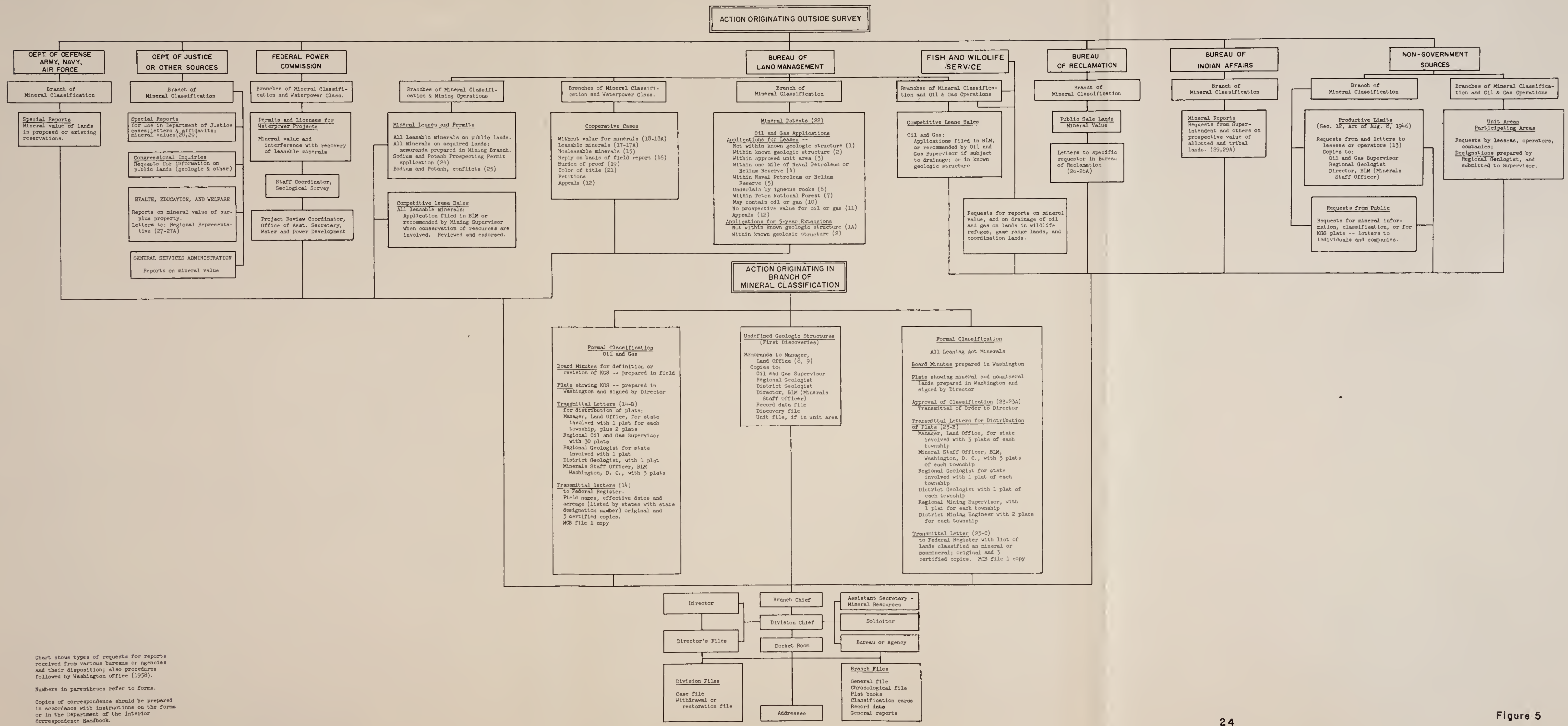


Chart shows types of requests for reports received from various bureaus or agencies and their disposition; also procedures followed by Washington office (1958).

Numbers in parentheses refer to forms.

Copies of correspondence should be prepared in accordance with instructions on the forms or in the Department of the Interior Correspondence Handbook.

Figure 5
July 1960

1944 (50 USC, sec. 1611 and the following)." Leases for any mineral other than those specified above are made pursuant to the regulations for certain acquired lands as given in 43 C.F.R. 200.31.

Indian lands.-- Geologic investigations of restricted, Tribal, and alloted Indian lands are made for the purpose of advising the Bureau of Indian Affairs concerning prospective mineral value of Indian Reservations or of other lands involved in various treaties with the Indians (See Bureau of Indian Affairs in Section B, Chapter V.)

OFFICES OF BRANCH OF MINERAL CLASSIFICATION
CONSERVATION DIVISION - U. S. GEOLOGICAL SURVEY

BRANCH CHIEF
3244 GSA Building, Washington 25, D. C.
Tel: REpublic 7-1820, Ext. 3787

EASTERN REGION
Headquarters:
Regional Geologist
3240 GSA Building
Washington 25, D. C.
Tel: REpublic 7-1820, Ext. 3738

MID-CONTINENT REGION
Headquarters:
Regional Geologist
608 Midstates Building
6 East 5th Street
P. O. Box 311
Tulsa 3, Oklahoma
Tel: LUther 4-7161

NORTHWESTERN REGION
Headquarters:
Regional Geologist
916 1st Avenue N.
P. O. Box 1827
Great Falls, Montana
Tel: GL 2-2008

ROCKY MOUNTAIN REGION
Headquarters:
Regional Geologist
Bldg 25, Denver Federal Center
Denver 14, Colorado
Tel: BElmont 3-3611, Ext. 405

Sub-Offices:
District Geologist
457 Federal Building
Salt Lake City 1, Utah
Tel: ENipine 4-2552

District Geologist
305 Federal Building
P. O. Box 400
Casper, Wyoming
Tel: CAsper 3-4561

SOUTHWESTERN REGION
Headquarters:
Regional Geologist
Farnsworth Bldg.
120 W. 2nd Street
P. O. Box 6721
Roswell, New Mexico
Tel: MAin 2-1332

Sub-Offices:
District Geologist
504-A Canal Street
P. O. Box 829
Carlsbad, New Mexico
Tel: TUxedo 5-6454

District Geologist
208-B West Main St.
P. O. Box 965
Farmington, New Mexico
Tel: DAvis 5-9382

WEST COAST REGION
Headquarters:
Regional Geologist
1036 Bartlett Building
215 West 7th Street
Los Angeles 14, California
Tel: RIchmond 9-4711, Ext. 125

Sub-Offices:
District Geologist
P. O. Box CC
Taft, California
Tel: TAft, 5-4234

District Geologist
509 Cordova Building
Anchorage, Alaska
Tel: BRoadway 8-2794

Note: Mail should be addressed to post office box only, when applicable.

CHAPTER II

CHAPTER II. -- BASE MAPS AND MATERIALS

GENERAL

Geologists of the Branch are responsible for the preparation of complete economic-geology maps that are capable in each instance of being translated readily in terms of applicable classification standards. The importance of careful preparation of these maps cannot be over-emphasized.

The information presented in this chapter has been extracted from several sources to supply a general review of the working materials that may be useful in developing economic-geology maps of a high standard.

SOURCES OF BASE MAPS

Map Information Office, Topographic Division

Inquiries from the public and from government agencies as to the availability of maps, photo-maps, aerial photographs, and vertical and horizontal control data should be directed to the Map Information Office, Topographic Division, U. S. Geological Survey, Washington 25, D. C. That office indexes the mapping and aerial photographic activities of Federal agencies and also some state and private activities. It is not a procurement organization. It provides information on the specifications and sources of topographic and planimetric maps, photo-maps or mosaics, aerial photographs, and geodetic control.

The Map Information Office periodically publishes index maps of the United States which show existing coverage by several kinds of base map materials. Geologists should be familiar with these "status maps" which, except for those marked "for administrative use only,"

are also available to the public without charge on request, as follows:

a. STATUS OF TOPOGRAPHIC MAPPING
   1. UNITED STATES, scale 1:5,000,000
   2. AREAS OUTSIDE OF CONTINENTAL UNITED STATES (Alaska, territories, and possessions), various scales.

These maps show areas covered by topographic and planimetric maps (primarily those published by the Geological Survey), together with an appraisal of their usefulness. Issued annually.

b. AREAS COVERED BY PUBLISHED TOPOGRAPHIC MAPS, scale 1:5,000,000 (for administrative use only).

Shows coverage by "best" published maps of all agencies. Issued annually.

c. TOPOGRAPHIC MAPPING - PROGRESS OF OPERATIONS (for administrative use only)
   1. UNITED STATES, scale 1:5,000,000
   2. AREAS OUTSIDE OF CONTINENTAL UNITED STATES, various scales.

Shows status of current mapping by the Geological Survey and other Federal agencies. Issued semi-annually.

d. SALES INDEX OF TOPOGRAPHIC MAPS FOR EACH STATE OR AREA

These indices show those published Geological Survey maps that are available. Issued once or twice a year, on an average.

Advance material indices for each state or area. These maps show status and availability of USGS topographic mapping in progress; issued quarterly.

e. AERIAL PHOTOGRAPHY OF THE UNITED STATES, scale 1:5,000,000

These maps show areas photographed by or for Federal, State and commercial agencies, and the agency which holds the negatives, from which reproductions are available by purchase.

f. AERIAL MOSAICS OF THE UNITED STATES, scale 1:5,000,000

These maps show areas covered by photo-maps or mosaics prepared from aerial photographs, scale of the mosaics, dates of mosaic compilation (or in some cases, dates of photography), and agencies from which copies may be purchased.

Formerly, the Topographic Division published 1:5,000,000 scale maps showing the status of horizontal and vertical control in the United States. The issuance of these maps has been discontinued. For information of this nature the appropriate regional office of the Topographic Division should be consulted.

Branch of Distribution, Geological Survey

Topographic and geologic maps for official use published or distributed by the Geological Survey are available by mail from the three following offices:

a. Maps of areas east of the Mississippi River, from:
   Chief of Distribution
   U. S. Geological Survey
   Washington 25, D. C.

b. Maps of areas west of the Mississippi River, from:
   Distribution Section
   U. S. Geological Survey
   Denver Federal Center
   Denver 14, Colorado

c. Maps of areas in Alaska, from:
   Distribution Section
   U. S. Geological Survey
   520 Illinois Street
   Fairbanks, Alaska

Orders from the public should be addressed to one of the above offices. Similarly, orders for Survey-distributed maps for official use may be sent to one of these offices, using official forms (letterhead) and procedures. The Fairbanks office does not distribute publications.

Office of Public Inquiries, Geological Survey

Survey maps and publications may be consulted in the libraries of the Survey in Washington, D. C.; Denver, Colo.; Salt Lake City, Utah; Los Angeles and San Francisco, Calif.; Dallas, Tex.; Anchorage, Alaska; and Spokane, Washington. These offices sell Survey maps and publications over-the-counter and act as repositories for selected open-file reports. Survey personnel should, however, obtain maps and publications from the offices of the Branch of Distribution as indicated in the preceding paragraph.

MAP PROJECTIONS

General Description

The basic map grid of latitude parallels and longitude meridians is called a map projection. Maps are variously constructed according to one or more of several projection schemes for representing the curved surface of the earth on the plane surface of a sheet of paper.

Although the Hayford spheroid is used in geophysical research and was adopted by the International Geophysical Union as the most accurate determination of the geoid, the curved surface of the earth generally adopted by geographers for representation is that of the spheroid defined by A. R. Clarke in 1866. From the earth's dimensions, as calculated by Clarke, tables have been developed that give the lengths of meridians and parallels for the various types of map projections.

The projections that are used allow the plotting of shapes, areas, distances, and azimuths with the minimum amount of distortion. No projection is distortion-free, but most of them attain nearly perfect representations of one or more of these features at the expense of others. The choice of projection depends largely upon the position assumed on the spheroid, the size of the area to be represented, and the use of the map.

Polyconic Projections

Quadrangles in the topographic and geologic map series published by the Geological Survey are based on the polyconic projection which, for areas of small extent, preserves shapes, areas, distances, and azimuths within narrow limits. This projection is simple to construct from existing tables. In it, the central meridian is a straight line, the

other meridians are curves concave toward the central meridian, and the parallels are curves concave northward north of the equator. This curvature is too small to plot on a $7\frac{1}{2}$-minute quadrangle, and all the meridians and parallels are shown as straight lines intersecting at right angles. On 15-minute, 30-minute, and 1-degree quadrangles, the meridians are shown as northward converging straight lines of equal length, and the parallels as straight lines between the 5-minute meridians of longitude.

Sources

Polyconic projections may be traced from previously constructed quadrangles at the same latitude if the scale is adequate, or they may be constructed from tables and instructions published in U. S. Geological Survey Bulletin 809 or Coast and Geodetic Survey Special Publication No. 5 (see topic "Construction of Projections"). Dimensions in inches for polyconic projections at 1:20,000 scale are given in a special table available from the Topographic Division on request.

Projections may also be obtained from the Topographic Division; requests should be made through the Branch office, giving limiting latitudes and longitudes, type of projection (such as, polyconic, Mercator, Lambert conformal conic, and rectilinear), scale, kind of paper or plastic, date when needed, and the project designation.

GEODETIC CONTROL

Kinds

There are two kinds of geodetic control, horizontal and vertical; each is classified according to accuracy into four orders. First- and second-order work usually is performed by the Coast and Geodetic Survey.

Third-order work and some second-order leveling is performed by the Geological Survey's Topographic Division. No standard station-marking tablets are established by these two organizations for work less accurate than third-order. Fourth-order work includes tape and stadia distance measurements and vertical angle elevation measurements.

Accuracy

A tabulation follows of the first three orders of accuracy for triangulation, traversing, and leveling:

	Order 1st	2nd	3rd
Triangulation:			
Average triangle closure	1 sec	3 sec	5 sec
Check on base line	1:25,000	1:10,000	1:5,000
Transit Traverse:			
Position check	1:25,000	1:10,000	1:5,000
Leveling:			
Permissible closure error in feet 1/	0.017	0.035	0.05

1/ Times length of circuit in miles.

Horizontal Control

Horizontal control consists of an integrated network of "triangulation points" or "transit traverse stations," whose latitude and longitude are accurately determined with respect to a common datum known as the "North American Datum of 1927." Elevations of these stations above sea level have not necessarily been determined. Work done prior to 1927 is being adjusted to the 1927 datum as rapidly as possible. If the refinements of that adjustment are required, it should be so specified in requesting horizontal control data. All data used in any map compilation project should preferably be based on that datum, as in many localities astronomic positions differ considerably from datum. Horizontal control stations are designated by name, such as RED, SAND, and CANU.

Vertical Control

Vertical control consists of an integrated network of stations, called "bench marks," whose position with respect to sea level is accurately determined. The horizontal position of a bench mark has not necessarily been determined. The sea level datum to which all elevations have been or are being adjusted is the "Mean Sea Level Datum" defined in 1929 by the Coast and Geodetic Survey. Elevations adjusted to this datum should be used exclusively. Vertical control stations are designated collectively in lines (usually run along roads, railroads, and rivers), between places, such as, "from Atlantic southwest along rock to Roach," "from Plum east along MKT Ry. to Boggy Tank."

Sources

Horizontal and vertical control lines established by the Geological Survey, the Coast and Geodetic Survey, and other federal agencies were shown on two index maps of the United States, now discontinued. More detailed indices of horizontal and vertical control are available on the 1:500,000 scale state base maps, in several 18- by 24-inch sheets per state. Horizontal and vertical control are shown on separate sheets. These sheets may be ordered for preliminary reference in planning a request for the detailed descriptions and positions of triangulation stations and lines of levels.

Positions and descriptions of triangulation and leveling stations are published in Geological Survey and Coast and Geodetic Survey bulletins. It is not necessary, however, to obtain these

bulletins; in fact, because of the adjustment to newly adopted datum, as mentioned above, and because of re-surveys, it is often undesirable to do so. The detailed description and position of points may be requested direct from the Coast and Geodetic Survey. Request "available control" in a specific quadrangle or county, or in an area defined by latitude and longitude, or specify the individual station name or level line, in all cases giving the state in which the area or stations are located. The information is then abstracted from the publications and from unpublished data, adjusted to datum, if necessary, and set out in printed sheets or typed pages. Request only the points and lines needed for use.

TOPOGRAPHIC MAPS

Topographic maps of standard accuracy and content are the preferred base maps inasmuch as all general purpose geologic mapping will be done on topographic quadrangle sheets as a rule. Other kinds of base maps are frequently necessary expedients or substitutes. Topographic maps of standard accuracy and content are made by field surveys with plane table and alidade, controlled by theodolite and transit triangulation and transit and level surveys. They are also made from vertical aerial photographs by photogrammetric methods, controlled by ground surveys with theodolite, transit, level, and camera-transit or photo-theodolite, and field checked for accuracy and completeness.

The Geological Survey publishes 15 minute topographic quadrangle maps at a scale of 1:62,500 and $7\frac{1}{2}$ minute maps at a scale of 1:24,000, including some maps originally compiled by other federal agencies.

Topographic maps showing river surveys at various scales are also available from the Survey, as well as recent topographic maps at a scale of 1:250,000 for nearly all areas not yet covered by quadrangle maps.

General Policy

Special copies of base maps, either published or in process of construction, can usually be obtained to meet the geologist's needs. Not only does this apply to maps made by the Geological Survey, but also to those made by other agencies. These should be requested through the Branch of Mineral Classification office in Washington as they are frequently costly.

Orders

Many of the details of their procurement require the maximum cooperation of other Divisions or agencies, and these matters can best be handled through the Washington Branch office, particularly if a charge is involved. A check should be made of our Division offices and of county and state agencies before ordering maps not available locally.

Special Copies of Published Maps

Special Press-run Copies

At the time that a U. S. Geological Survey topographic map goes to press, opportunity is afforded Survey Divisions to obtain special copies of prints from drainage, culture, or contour plates printed alone or in special combinations, or the complete map, either in one color or the standard colors, on various media, such as, Draftex and drawing paper. These must be requested at the time of the press-run

if they are to be obtained at small cost. The same kinds of special prints can only be obtained subsequently after considerable time and at substantial expense.

Enlarged Copies of Published Maps

The almost universal use of photolithographic reproduction of maps for publication demands preparation of manuscript copy on a larger scale which is then reduced by photography to the published scale. It is also advantageous to do the field work for a map at a scale larger than that at which it is to be published, hence there is much demand for enlarged copies of the base map, either for actual field mapping or for author's copy or both and for color-separation drafting of the final map. Usually the base map is reprinted from the plates used for the topographic edition, and the new geologic plates must register with them. The best plan is to make the enlarged base from the published map. This not only helps to insure close registry but, inasmuch as the copy contains all lines and letters that appear on the published topographic base, it also facilitates the placing of geologic symbols in positions where they will not coincide with information printed on the base.

Enlarged copies of published maps can be made by the Branch of Map Reproduction in Washington on a repay basis, the cost charged to the particular project involved. They are made by photographing the printed map on a glass-plate or film negative and then either making positive prints photochemically or making a new printing plate and making the positive copies in the press. Photochemical printing (usually in nonphotographic blue lines) is less costly and can be done on scale-true metal-mounted paper which cannot be handled in the presses.

The enlargement is frequently done in sections with overlap between the sections. This is due to the limitations imposed by the size of the plate or film and camera, but the sections can be recombined into one large sheet during the printing. The map can be printed photochemically in black on regular photographic paper and in nonphotographic blue on double-mounted plane table paper, metal-mounted sheets, Draftex, Dyrite, and similar materials that are waterproof or will not be otherwise affected by the application of the wet emulsion or by the developing and fixing baths. The map can be printed in any desired color (photographic or nonphotographic) on drawing paper, tracing linen, Draftex, Dyrite, or regular coated paper, but not on a very thick medium such as double-mounted plane table paper.

In the past, photochemical prints in nonphotographic blue have been known to fade when exposed to strong direct sunlight. Even though the lines reappear when the light is reduced, it seems essential to have the map visible during the middle of the day for plotting. This is a problem for the photo-laboratory, but the precautionary use of a cover sheet is probably always advisable.

Copies of Maps in Progress

If the project schedule does not permit waiting for the topographic base map to be published, various kinds of copies of maps in preparation can, under most circumstances, be obtained.

State Advance Materials Index Maps are printed quarterly, showing status of work in progress, and may be obtained from the Rolla, Denver, and Sacramento offices of the Topographic Division.

Blue-line Prints "Before Field Completion"

Most topographic maps are now made by photogrammetric techniques which require that the map be checked and completed in the field prior to publication. From the manuscript, non-photographic blue-line prints are made up on which the field-completion engineer makes the changes and additions and completes the contouring in areas that were obscured on the air photos. The scale of these prints is 1:20,000, all being $7\frac{1}{2}$-minute quadrangles. One or two copies of these prints may be available without cost from the Topographic Division, on lightweight paper, unmounted; and by filing an advance request, additional copies could be made at small cost. Such maps at this stage are not finished products; contours may not be completely drawn, names or indentifications other than control stations may not be noted, and the paper does not hold scale well unless it is mounted on metal. At this stage, the maps may be extremely useful in the field, but final copy should not be prepared on such bases.

Blue-line prints "After Field Completion"

After the field completion surveys have been made, blue-line prints (also at the 1:20,000 scale) are made, to be used for the final color-separation inking. One or two copies of this version are usually filed in the Map Information Office and may be requested, or additional copies may be arranged for as indicated in the preceding paragraph. Drainage and culture are complete, but contours in "tight" areas may not be completely drawn in, and there are no labels identifying places or natural features. This, however, is the earliest stage at which metal-mounted prints should be obtained for drafting final geologic copy.

Copies of Manuscript Base Maps

If the standard preliminary scale of 1:20,000 used by the Topographic Division does not meet the geologist's needs, special prints at any desired scale may be made in the various forms mentioned under "enlarged copies of published maps" by photographing the manuscript map after the results of the field completion surveys have been added to it. The expense involved in such a reproduction makes it unwise, in general, to do it before the map has been checked and completed, although some circumstances may require it.

The manuscripts of some topographic maps produced by photogrammetric means contain information such as plotted positions of air-photo centers, control stations, fence lines, vegetation, isolated trees, and other landmarks that may prove very useful in the course of geologic field work. (This kind of information also appears on the blue-line prints before and after field completion.) The results of field completion surveys are also added to the manuscript. Drafting is not refined or complete, but the scale is very large (though possibly somewhat inaccurate), usually between 1:10,000 and 1:20,000. Copies of the manuscript map are usually made in several sections per quadrangle and are quite expensive.

PLANIMETRIC MAPS BY VARIOUS AGENCIES

Planimetric maps show natural or cultural features in their horizontal positions, but there is no quantitative representation of relief. Various agencies make planimetric maps to show information such as drainage, political subdivisions, property lines, vegetation, soils, or geology. On some of these maps the positions of divides, peaks, or

other landmarks are shown. These maps are often of great service as bases for geologic mapping.

Geological Survey

The Topographic Division of the Survey has published some planimetric maps of standard accuracy, which show cultural and hydrographic features. These maps cover areas of very low relief, and may be ordered from the Branch of Distribution.

In constructing maps of some areas of low relief, planimetric bases are prepared photogrammetrically, and contours are added by field surveys. These planimetric base maps may be of great value to the geologists even before the completion of the contours. One or two blue-line prints may sometimes be obtained without cost from the Topographic Division, but additional prints or more substantial field copies will have to be arranged for specially by the Branch office.

Soil Conservation Service

In the southwestern United States, the Soil Conservation Service has prepared many mosaics and planimetric maps of 15-minute quadrangles covered by their aerial photography. The minimum of horizontal control has been used in their compilation and has resulted in local errors in some maps. Ozalid prints of these maps are available at two scales, 1:31,680 and 1:63,360. The prints may be ordered and the order should state the latitude and longitude of the quadrangle and the state in which it lies.

Grazing District Maps

These are planimetric maps covering a number of township sheets included in grazing districts and will be found useful where other

base maps or Survey quadrangle sheets are not available. The source data includes township plats, State highway department maps, Forest Service data, and CCC programs. In the compilation of recent maps, aerial photo mosaics and U. S. Geological Survey topographic quadrangle sheets are utilized. Most maps show drainage, railroads, and access roads although the accuracy and completeness varies from map to map. Mines and prospects are occasionally included, and, with few exceptions, lots and land ownerships are indicated. Small scale maps (1:126,720; 2 miles to the inch) may cover an area in excess of 5,000 square miles. Larger scale maps (1:63,360; 1 mile to the inch) are usually available and more complete, and may cover an area in excess of 1,300 square miles. On some of the maps the general outlines of topographic features are shown by hachures. On more recent maps contours (1,000 foot intervals) have been employed. Copies are obtainable through District Grazing offices, Bureau of Land Management.

Township Plats

General

The Federal system of public-land surveys in the western states affords data that are frequently used in preparing base maps or as control in the compilation of a new base map. The unit of the system is the township, a tract six miles square, or nearly so, bounded on the east and west by north-south lines, and on the north and south by east-west lines, and subdivided into 36 sections, each a mile square or nearly so. As the true north-south lines, which are meridians, converge northward, the township is actually a trapezoid and not a square, and inaccuracies of surveying add further complexities which produce a

land net that is in reality quite far from a simple rectangular grid. One of these added complexities, for example, is the standardized procedure of throwing all the errors of closure in surveying into the last mile of the traverse; in surveying a latitudinal township boundary, into the last half mile at the west end of the line; and in surveying sections, into the westernmost and northernmost quarter-sections of the townships. Such variations from the ideal make it imperative to consult the township plats and the surveyor's notes in order to determine the actual bearings and distances between section and township corners. The "Manual of Instructions for the Survey of the Public lands in the United States" (Bureau of Land Management, 1947) and Geological Survey Bulletin 788, pages 368-378 (Birdseye, 1928) should be studied if the public-land surveys are to be used.

Source

Township plats and the engineer's notes are available in photostat form from the Branch of Field Services, Bureau of Land Management, Department of the Interior, Washington 25, D. C., or from the local land offices or area offices of the cadastral engineers.

Orders

Request township plats through the Branch offices, giving township and range numbers and the principal meridian to which these numbers are referred; state and county should be added as a check. State whether the Survey notes are also needed. Plats may be examined at the Land Offices of the Bureau of Land Management. Plats and maps may also be consulted at the State Engineer's, county engineer's, or county assessor's offices.

County Road Maps

The highway departments of the several states, in cooperation with the Federal Public Roads Administration, prepare county road maps showing most existing roads and the larger streams. Black-line, blue-line, or blue-print copies may be purchased from the State highway departments or their authorized distributing agents. Scales are 1, 2, and 4 miles per inch; some states make two of these scales available. In many cases several sheets are required to cover one county. The cost is $0.50 to $1.00 per sheet; a few states, however, furnish these maps without charge to Federal Government agencies.

Copies of all county road maps, and information as to the scales, prices, and sources are on file in the Map Library of the Public Roads Administration, in the same building as the Survey offices in Washington. Orders for such material may be directed through the Branch office, or may be made directly in most State capitals and many county seats.

National Forest and Indian Reservation Maps

Planimetric maps of National Forest preserves and of public lands set aside for the use of Indians are compiled from various sources for administrative use. They usually show prominent landmarks, main drainage, roads, and land-survey lines.

Black-line or blue-line prints of the Forest Service maps are available at a scale of 2 miles per inch. Some are prepared by radial plot from vertical aerial photographs and show the positions of the photograph centers. One or two copies are usually furnished without cost on application to the appropriate Regional Forester's office, U. S. Forest Service, Department of Agriculture, or they may be requested through the Branch office. Maps of Indian reservations, commonly photolithographed in black at scales of 1, 2, or 4 miles per

inch, are available from the respective reservation headquarters of the Bureau of Indian Affairs, Department of the Interior, or may be requested through the Branch office, if funds are involved.

SMALL-SCALE MAPS OF LARGER AREAS

Although not frequently used as base maps for geologic field work, small-scale maps of areas comprising several quadrangles or whole states are sometimes needed for presentation of regional compilations of geologic data. Such base maps commonly do not attempt to show topographic relief. Those which have proved useful are briefly noted below.

Topographic Maps of the United States

The most important and useful of these small-scale maps is the series inaugurated in 1950 by the Topographic Division of the Geological Survey as an outgrowth of work begun by the Army Map Service. Each sheet in the series is printed in colors at 1:250,000, and covers 1 degree of latitude and 2 degrees of longitude. They show drainage, culture, and 100-foot contours, which may be supplemented by 50-foot contours in areas of low relief. These are available from the regular topographic map distribution offices of the Survey. Some of the maps in this series carry a shaded-relief or a woodland cover overprint, but copies without such information may possibly be procured by special arrangement through the Branch office.

State Transportation Maps

These maps are printed in six colors at 1:250,000 in several sheets per state; they show main drainage, townships, place names, highways, railroads, canals, air-lanes, and dredged channels, and can be ordered from the Public Roads Administration.

Aeronautical Charts

These maps are published in color in scales of 1:1,000,000, 1:500,000, and 1:250,000; some show topographic relief by color in addition to the major rivers, important towns, and air navigation information. Some charts are available without the air information overprint and make more appropriate base maps. There is no charge for copies for official use; they should be requested from the Coast and Geodetic Survey. They can also be purchased locally at moderate cost.

State Base Maps, Geological Survey

Outline maps of each state in two or three colors, with scales either at 1:500,000 or 1:1,000,000 that show streams, cities, railroads, and county boundaries, are available. Those recently revised are available with a red overprint showing main highways. They are supplied for official use without charge by the regular distribution offices.

International Map of the World, Geological Survey

Sections of this map are printed in colors showing culture, hydrography, and hypsography at 1:1,000,000 in sheets covering 4 degrees of latitude and 6 degrees of longitude. None of the United States sheets have been published; the others are supplied for official use without cost by the regular distribution offices.

Base Maps of the United States, Geological Survey

1. A three-color map, composed of two sheets at a scale of 1:2,500,000, shows political divisions, water features, and railroads and is available from the distribution offices.

2. A one-color or two-color outline map showing states and counties at 1:5,000,000 is available from the distribution offices.

3. A two-color outline map showing states and counties in black, and 15-minute meridians and parallels in green or orange, is available at 1:5,000,000. The supply is strictly limited and the map may be used for administrative purposes only; copies are available on request through the Branch office.

MOSAICS OF PHOTOMAPS

General Description

Mosaics are prepared by tearing or cutting contact prints of vertical aerial photographs into segments and carefully matching the segments together to form a continuous large vertical photograph of an area. The assembly of matched print segments is then photographed onto a film negative, or in the case of large areas, onto several negatives, from which photographic prints are made on order, or from which photolithographic copies are printed for distribution. In some cases enlargements or reductions from the scale of the copy negative may be obtained by projection printings.

Mosaics are produced in a number of degrees of refinement. They may consist simply of matched print-segments (uncontrolled mosaics); of print-segments matched and fitted to skeletal control to partially correct scale (semi-controlled mosaics); or of print-segments matched and fitted into a controlled radial plot (controlled mosaics); or of rectified and ratioed print-segments fitted to a controlled radial plot (precision mosaics). The amount of precision work required to make a satisfactory mosaic varies with the local relief owing to relief displacements and consequent scale variations within each individual contact print.

Recently the term "photomap" has been applied to mosaics. It is essentially a planimetric map as it affords no quantitative representation of relief, but it rarely meets standards of uniformity of scale usually expected of a map. In areas of low relief, it may be used on a plane table as a map would be used, but in more rugged areas a precisely controlled mosaic is needed to work satisfactorily in this manner. Such considerations are of less significance if the mapping is to be published at greatly reduced scale.

In the absence of a base map, mosaics are very useful in conjunction with contact prints of aerial photographs. Details that have been mapped on the prints in the field may be compiled on the mosaic by inspection or by stereoscopically pairing the print with the appropriate part of the mosaic and transferring while viewing the model stereoscopically. In less precise mosaics, however, parts of the contact prints may be omitted, or even repeated, in order to fit the perspective view of the aerial photograph into the horizontal map projection of the mosaic. For example, slopes facing the camera may be lengthened and those away from the camera may be shortened on the aerial photograph. Unless the parts of the photograph are to be ratioed into correct scale, the lengthened slope has to be cut short to make it fit into its alloted horizontal space on the mosaic. The result is an omission of part of the picture, and the geologic contacts drawn in such areas have to be distorted or drawn without regard to the mosaic base.

Mosaics are sometimes compiled in convenient units covering standard quadrangles, but are usually special purpose sheets without systematic development into a larger scheme. Rarely is there uniformity

of scale or of the type of map-projection adopted. Many of the topographic maps published by the Army Map Service have a half-tone mosaic of the quadrangle on the reverse of the sheet. Other suppliers of mosaics are the Production and Marketing Administration, the Soil Conservation Service, the U. S. Air Force, and the Aero Service Corporation. Mosaics are photographic reproductions, and for general use should be printed on double-weight, semi-matte paper unless they are to be used as illustrations in a printed report, when they should be printed on glossy paper.

Orders

Orders should be sent through the Branch office, giving state, county, latitude and longitude boundaries or township and range of coverage desired, scale desired or acceptable, date needed, project fund to be charged, and directions for delivery.

AERIAL PHOTOGRAPHS

General Advice

Mapping in the field on aerial photographs permits the geologist to speedily and accurately plot the geology without instrument work, but this method has its limitations. It is limited by the kind and amount of vegetation in the area; photo-mapping will not work everywhere. In addition, it requires rather elaborate operations and equipment either to combine the several photographs into a map or to transfer the geology to a map. The photograph lacks uniform scale, uniform and true azimuths, and elevations with respect to a datum; therefore, quantitative measurements of distances, bearings, and elevations are impossible until the photographs are corrected into a map. The time-consuming processes of making the map from the photographs, some

of which are described elsewhere in this manual, are the penalties for doing the field geology without instruments. The important point is that these subsequent photogrammetric procedures are just as much a part of the assignment as is the actual field plotting on the photographs. Aerial photographs afford many advantages and are an important tool, but the making of a map can only be postponed, not avoided; no map -- no geology. If a map is already available to which the geology can be transferred, the photogrammetric part of the job is relatively simple, but if a new map is to be made, there is also the necessity of obtaining ground-control stations. Usually this requires some plane table or transit triangulation by the geologist, and frequently some form of elevation determination to permit structure contouring.

The characteristics or specifications of the particular aerial photograph used also prescribe to a very large extent the methods that can be adopted at the later stages of map compilation or geology transfer. The focal length of the aerial camera and, indirectly the scale of the photographs, limit the choice of a plotting instrument. A long focal-lenght lens produces a larger-scale photograph than a short-focus lens when used at the same flight height. The short-focus lens, therefore, requires fewer exposures to cover a given area, and this is a very important consideration because costs of photogrammetric map compilation are directly proportional to the number of photographs involved. The savings are increased still further by using lenses with wide angular fields of view; such lenses also introduce considerable distortion near the edges of the field. (Long-focus lenses in general have narrower fields and less distortion.) Using a lens of given design,

the number of photographs also is reduced by flying at high altitudes, but the scale of the negatives is reduced. Specifications of each photo-project are thus a compromise between scale needs and economy. With the advent of stereoplotting instruments that work at enlarged scales, the former consideration became secondary, and the tendency toward higher flying in improved airplanes using wide-angle lenses of shorter focal-length to produce smaller scale photographs has been marked. Generally speaking, mapping photographs, designed for maximum coverage, are taken with wide-angle lenses of 5- or 6-inch focal length at scales between 1:25,000 and 1:35,000.

Scales of this magnitude mean that geologists must resort to enlargements of some photographs for field use, which in turn restricts the choice of stereoplotters to the Multiplex or Kelsh. The Department of Agriculture, whose photographs are much used for field plotting, has retained longer focal-length lenses (8-1/4 inches), and at moderate elevations to produce negatives at 1:20,000. This entails somewhat higher costs in map compilation, but permits direct use of contact prints (for most jobs the scale is large enough) both in the field and in the Mahan, K.E.K., and Kail plotters. These plotters are somewhat less elaborate and costly (though probably equally difficult to master) than the Multiplex or Kelsh, but they cannot accomodate enlargements. The Multiplex and Kelsh afford the advantage of very large working scales both in the field and in the plotter.

As the Geologic Division uses existing photographs wherever possible, complete standardization is impracticable. Both small-scale wide-angle and large-scale narrow-angle photographs must be used

according to their availability, and provision has to be made for handling map compilation from both types of photographs.

One other complicating factor related to the focal length of the aerial camera should be mentioned. The optical systems of stereoplotting instruments are designed around specific focal lengths, or even , as for example the Multiplex, around specific aerial-camera lenses; that is, they are designed to work with only one kind of photography. Most of the modern Multiplex equipment can use only aerial photographs taken with the wide-angle Metrogon lens of 5.2- or 6-inch focal length; a small amount of older Multiplex equipment can use only the $8\frac{1}{4}$-inch photographs, and uses only contact prints of such pictures. For some purposes these restrictions can occasionally be ignored. For example, the Mahan can, with enough additional control, use 6-inch wide-angle photographs; and planimetric-geologic maps have been constructed and geology has been transferred to an existing base map from such photographs by means of the Mahan with some success. If any plotter, however, is pushed behond its field of competence there is a sacrifice in accuracy and ease of operation, and the loss of accuracy is difficult to assess.

These various restrictions should be carefully considered, and the complete procedure of putting the geology out in map form be accurately planned at the start of each project as soon as the specifications of the available air photographs are known.

Types of Reproductions

Contact prints

Contact prints are 7" x 7", 7" x 9", 9" x 9", or 10" x 10" positive paper prints made at the size and scale of the aerial negatives.

Stereoscopic vs. Physical Coverage

Aerial photographs for mapping purposes are taken so that successive exposures in a flight strip overlap 55 to 65 percent; every point thus appears on a least two photographs. This enables a stereoscopic view of the entire area and is called stereoscopic coverage. For geologic mapping purposes complete stereoscopic coverage should always be purchased.

Although alternate exposures will give complete ground or physical coverage, to ignore the stereoscopic tool is not recommended. If a base map is to be constructed from the photographs, stereocoverage is absolutely necessary.

Enlargements

Enlargements are projection prints made from the aerial negatives at a more convenient size or scale. However, there is a loss of definition which increases with degree of enlargement. Enlargement of more than 2 diameters is not highly recommended, although in some cases it is possible to use up to 4 diameters.

Photo-indices

Photo-indices are reduced pictures of all contact prints in a photo-project showing the assembled prints in their correct position relative to each other. The usual scale is 1 inch to 2 miles. They may be enlarged to other scales up to two times. They facilitate the indentification of the individual prints required to cover a specific ground area and should be purchased with every order for contact prints (or enlargements if no contact prints are purchased). In addition, they may be purchased in advance of contact prints and used to select the contact prints required. The cost is $1.00 per sheet which covers an area roughly the size of a 15-minute quadrangle.

Mosaics

Mosaics are segments of contact prints pieced together to make a composite vertical aerial photograph of a quadrangle, a county, or other unit. They may be scaled to ground control ("controlled mosaic") or not ("uncontrolled mosaic"). The usual scale is 1 inch to 1 mile, but they may be reduced or enlarged up to two diameters. The cost of mosaics furnished by government agencies is nominal, but those purchased from commercial suppliers are expensive.

Ratio Prints

Ratio prints are prints whose scale is changed from that of the negative (through enlargement or reduction) on the basis of two or more ground control points.

Rectified Prints

Rectified prints are prints made in a projection printer equipped with tilting easel and have been "horizontalized" to three or more ground control points (tilt and tip removed).

Photographic Materials

Prints of aerial photographs may be ordered on a number of materials. Each of these materials has some special advantage. The following information is intended to assist the geologist in selecting the material most satisfactory for his particular need. Three of the most common materials are:

Double Weight Semi-matte Paper

Double weight, semi-matte is durable and will withstand hard usage particularly in a dry climate. The surface takes both pencil and ink well and withstands mild erasure. The paper and emulsion are flexible

and do not crack or chip in normal usage. The paper is not waterproof and the photographic image is not as clear and sharp as that on other types of material having a more glossy finish. The paper and emulsion are soft, and marks made with a pencil or ball point pen leave a groove in the surface after erasure.

For field use aerial photographs should be ordered printed on double-weight, semi-matte paper. Single-weight glossy paper is used for prints that are to be mosaicked or reproduced as illustrations. Low-shrink, semi-gloss paper is desirable and recommended in case the prints are to be used for a radial plot or for Multiplex transfer of geology. It is not very suitable for field plotting of geology as pencil lines rub off very readily (ink "takes" very well). It can serve well for office compilation and then be used to make the map or to transfer the geology to a map.

AMS (Air Map Special) Paper

AMS is a plastic impregnated paper that is essentially stable dimensionally. The paper itself is waterproof; however, the emulsion is not and is subject to moisture damage. The surface takes both pencil and ink well although pencil lines have a tendency to smear. The paper is harder than double weight paper and does not "groove" as easily and the finish is more glossy than semi-matte and presents a better image. If prints of the aerial photographs are to be used photogrammetrically in mapping or for measurement of geologic or other features, they should be printed on a dimensionally stable material such as AMS paper. Photographic prints on AMS paper cost approximately $0.10 per print more than prints on either double or

single weight paper.

Single Weight Glossy (Ferrotype) Paper

Single weight glossy prints will not withstand average field use and tend to curl and crack in storage. They are dimensionally unstable and should not be used in photogrammetric map compilations. Photographs of this type will not take pencil lines but take ink well. The surface is hard and does not "groove" as easily as the softer finishes. However, heavy pressure on the marking instrument or marking on the back of the print can crack and ruin the emulsion. The image presented is superior to that presented on either AMS or double weight paper, the paper is thin enough so that the photographs may be viewed with transmitted light further increasing the image clarity. These prints are recommended for photo-interpretation.

Film Positives

In addition to the paper print materials above, it may be found desirable to consider the use of film positives as they have some unique advantages. Film positives resolve more lines per millimeter than paper prints; also film emulsions have the capability of resolving more shades of gray than the emulsions used on paper prints, thus features not expressed and appearing as either white or black on paper prints may be expressed on film positives. Film positives may be viewed with transmitted light increasing their interpretability. Further, film positives may be inserted directly into a Kelsh Plotter.

Many other special types of materials for photographic prints are available to meet special needs. If you have a special problem you are

urged to consult the Interdivision Committee on Photogrammetric Techniques in Geology through its secretary or the photographic laboratory of the Topographic Division office nearest you.

It has been found beneficial to inform the photographic laboratory preparing photographic prints of the use that is to be made of the prints. Therefore, we urge that a statement such as "THESE PHOTOGRAPHS ARE NEEDED FOR GEOLOGIC INTERPRETATION. PLEASE PROCESS SO AS TO ACHIEVE BEST POSSIBLE QUALITY," be included in the original order.

Aerial photographs are taken by at least nine Federal agencies, some state governments, and many private enterprises. The agency purchasing the photographs normally also holds the negatives and makes reproductions available for purchase. Considerations of National security or industrial competition may locally restrict the use of existing photographs.

Organization	Address	Types of Photographs
U. S. Geological Survey, Topographic Division	Washington, D. C. Rolla, Missouri Denver, Colorado Sacramento, Calif.	Single-lens vertical air photographs, chiefly with lenses of 6-inch and 5.2-inch nominal focal lengths at various scales.
Dept. of Agricul.: Production & Marketing Adm. Soil Conserv. Serv. Forest Service	Washington, D. C. Salt Lake City, U. Beltsville, Md. Washington, D. C. Denver, Colorado	Single-lens vertical aerial photographs of 8-1/4" focal length at 1:20,000. Some older 4-lens photography at 1:31,680.
U. S. Air Force & Corps of Engineers	Washington, D. C.	Single-lens verticals and trimetrogon air photographs of various focal lengths and at various scales.
Tennessee Valley Authority	Chattanooga, Tenn.	Single-lens vertical photography with 4-inch focal length and 7- by 7-inch negatives, and much large-scale long-focal-length vertical photography.
Bureau of Reclamation	Denver, Colorado	8-1/4-inch photographs at 1:20,000 scale.
Coast & Geodetic Survey	Washington, D. C.	Single-lens verticals at 1:10,000 or 1:20,000 of 6- or 12-inch focal length, and 9-lens photography at 1:10,000 or 1:20,000 scale.
Department of the Navy	Washington, D. C.	Coverage of foreign, Alaskan, and island areas, mostly restricted and at widely varying scales.
States and Commercial		Specifications vary so greatly that no generalization can be made.

Orders

All aerial photographic reproductions should be ordered through the Branch office, to take advantage of blanket purchase orders and contract arrangements made annually by the Geologic Division. Requests for new aerial photography to be contracted by the Division should also be made through the Branch.

Request coverage as far in advance as feasible, stating:

1. Area -- give state, quadrangle or county or township and range, latitude and longitude.
2. Kind of coverage -- stereo or non-stereo; and type of reproduction -- photo-index, contact prints, enlargements, or mosaics.
3. Double-weight, semi-matte paper; low-shrink paper; or glossy paper.
4. Scales desired or acceptable.
5. Date needed for use.
6. Amount of money available to cover purchase.
7. Project fund to be charged.
8. Address to which pictures are to be sent.

If the specific numbers of the exposures of the required prints are known they should be listed. All exposures are identified in the upper right corner, or center of upper edge, by a project designation (ADJ, ESA, or a number), roll number, and exposure number (3-109, IF-1 or similar number), and sometimes by an agency symbol (GS, SCS, or similar symbol).

It is essential to inform the Washington office of receipt of the order, even if, in the case of direct shipments, the geologist completes the furnishing agency's receipt. The bills cannot be paid until it is known that delivery is complete.

CHAPTER III

CHAPTER III. -- MAPPING STANDARDS AND TECHNIQUES

DEVELOPMENT OF MAPS AND DATA IN FIELD OFFICES

Of the various types of reports that Branch geologists are called upon to prepare, those pertaining to formal classification actions should be given particular attention. The material presented in this chapter is intended to provide a basic idea of the work necessary and the information required in support of classification actions.

Although mapping techniques are standardized, some of the material herein is applicable only to bedded deposits of leasable minerals and is classed as special-purpose geologic mapping. Inasmuch as mapping for all formal classification purposes will be done on a quadrangle basis in order to be acceptable for possible publication, it is believed that the methods outlined will be helpful for the migratory as well as the solid minerals. With this in mind, the discussion on mapping techniques and map compilation is devoted mainly to requirements for bedded mineral deposits, although certain requirements are applicable to other deposits as well.

The mapping of oil and gas structures involve the same principles and degree of accuracy. For individual oil and gas field maps compiled from subsurface data, a separate technique is employed because the results are dependent on well logs.

The principles expressed do not cover all variations of mapping problems that may be found. It is intended, however, that they serve as a guide to the Branch geologist in mapping and preparing the results of his work in a form that will be acceptable for publication as well

as for land classification. In this latter respect Branch geologists have the responsibility of presenting the results of their field work in a form pertinent to the problem of practically and factually classifying and reducing the acreage in outstanding mineral withdrawals.

For the most part the Regional field offices are in a position to schedule work looking toward the classification of limited areas. Any classification project, however, should be submitted to the Washington office for approval, and should be accompanied by an appropriate justification or explanatory memorandum giving cost, map scale, starting date, and target date. Special requests may be received from the Washington office, however, that will indicate priority on an area of greater need. Such areas of more than a fourth of a township should be scheduled only after approval by the Branch Chief.

Accuracy is of first importance in field work for classification purposes. A separate set of field notes shall be kept for each township. Photographs, together with titles and locations, will be included with the geologic notes. The notes must be complete, clear, and systematic because they will be used for classifying the land, and because others than their author may use them for compilation or future reference. While at a station, the geologist should make all required observations, so that it will not be necessary to return later to supplement his work. Field records and notes are to be kept in the field offices. The date on which the work was performed is important, and notes should show the date as well as the names of the individuals who performed the work.

GEOLOGIC MAP STANDARDS

The following discussion by Dr. W. H. Bradley, Chief Geologist, concerning the classification, definition, and standards for geologic maps, is extracted from a memorandum dated February 14, 1956, to all professional and supervisory personnel in the Geologic Division. A committee on geologic mapping prepared the memorandum which represents the latest thinking of the Geologic Division regarding map standards and classification:

"General Geologic Maps

"The Committee recognized that a large proportion of Survey geologic mapping must continue to be for special purposes but that there is a growing need for more general geologic maps. A general geologic map (and it may take two or more maps to provide adequate geologic map coverage for a given area) is defined as one (or more) that is suitable as an independent unit in the geologic map coverage of the United States and its Territories and that has the following properties:

1. Mapping scale should be 1:63,360 or larger. (In general, publication should be at the smallest standard scale consistent with the showing of all pertinent detail mapped. This generalization is not intended to lead to uneconomic reduction of a published map base in order to meet the objective, nor to imply that a map is not a general geologic map if it is published on a scale larger than the one specified.) Many maps made by plane table on 1:63,360 or larger have been reproduced on smaller scales. These maps should probably be classified on the basis of the manuscript copies, as the purpose of this classification is primarily for programming.

2. A topographic base is essential except in areas of little or no relief where the absence of contours does not hamper geologic interpretation. Planimetry, contour interval, and detail of contouring should meet the standards established by the Federal Board of Surveys and Maps. Though it is desirable that the culture be up to date, this need not ordinarily affect the classification of the geologic map.

3. All geologically significant units mappable at the scale should be shown. "Mappable" refers to that which can be identified by a field geologist using a hand lens and pick but little else in the way of special chemical, paleontologic, or other analyses. This does not imply that we should exclude from the general geologic map category refinements in mapping that can be achieved by use, when applicable, of such instruments, for example, as the petrographic microscope or the magnetometer. Also it is recognized that certain significant geologic units such as thin dikes, sills, or beds should be shown even though they must be plotted on an exaggerated scale.

4. Structure should be adequately portrayed and, if needed for clarity, structure sections should be on the same or an accompanying sheet.

5. Explanation should be concise, reasonably definite, and express the distinctive characteristics and principal variations in lithology of map units and also in thickness, if determinable.

6. The accuracy of location of faults and contacts should be shown by appropriate symbols (see new list of Geologic Map Symbols, by Cloos, Pusey, Rubey, and Goddard). Solid lines should be used to indicate accurate locations of features that are geologically identifiable within the plottable limits of the map and that can be located from exposures or other evidence within 1/25 inch on the map. (= 80' on 1/24,000) Solid lines should generally be within 1/25 inch of their true map position and in no case should they be mislocated with respect to geographically identifiable points more than 1/10 inch on any map. (⊢80'—|—80'⊣ 160') Features that are only approximately located should be shown by long dashed lines; those that are indefinite or inferred, by short dashed lines; and those that are concealed, by dotted lines.

The use of many dashed contacts or faults on a map is not to be construed as a detraction from the quality of the map, and for many maps, it may be undesirable or impossible to achieve sufficiently accurate locations to permit use of solid lines. The quality of the map is not impaired so long as the reader can interpret the accuracy of location.

7. Geologic interpretations should be internally consistent and plausible. For example, the plotting of contacts in relation to topography should be consistent with the structure indicated by symbols and structure sections.

8. Many special geologic maps, made to show such features as coal beds, aquifers, construction materials, and subsurface geology, are general geologic maps to which special information has been added. Some special geologic maps are restricted, however, to the illustration of special features and do not qualify as general geologic maps.

"Classification of geologic maps

"The following classification of geologic maps will be used in the Geologic Division for reporting status of geologic mapping and as a basis for programming. This list also defines standards of the classes of maps other than general geologic maps.

General geologic maps: (a) bedrock, (b) surficial -- defined above.

Special geologic maps: those showing only part of the rock systems occurring in the area, such as many surficial and water resource maps.

Reconnaissance geologic maps: all mapping at scales less than 1:63,360, including compilations such as state geologic maps and regional maps.

Inadequate geologic maps: geology or base is inadequate to meet standards.

Unclassified geologic maps: maps not yet reviewed for adherence to standards."

MAPPING TECHNIQUES

Topographic Base

If horizontal control within 50 feet and vertical control within 5 feet are required, a usable topographic map must have a scale at least as large as 1:24,000 and a contour interval no greater than 20 feet. Even with these specifications, not all the points sought as located on the map will be within these limits of error, for the topographic map will have been made using about the same limits. Furthermore, it should not be assumed that a smaller scale map having the requisite contour interval can be enlarged by photography to specifications, for if the scale of a topographic map is doubled, the detail used in its construction should be about 4 times as great. A topographic map is, of course, excellent for sketching water features and outcrops between points of geologic control.

Many geologists use topographic maps as plane-table sheets with

a telescopic or open-sight alidade, however, if accuracy requiring this method is needed, one can probably save time and gain accuracy by setting up and using his own plane-table triangulation net.

If the topographic map has been made from air photos, as most of them are nowadays, it may be possible to get an advanced sheet or photogrammetric manuscript on a larger scale showing centers of the vertical photos or a published map showing the centers printed on the back of the map. Then, using the greater detail of the photos for locations of points sought and the radial line method to determine their locations on the topographic map, geologic mapping is relatively easy.

Besides the usual methods of locating points sought and getting their elevations by the comparison of natural and man-made features on the map with those on the ground, compass triangulation, compass-and-pace traversing, and leveling are also useful. A compass, properly set for declination and having a balanced needle, may give useful bearings from prominent features shown on the map to intersections with linear features such as roads and railroads; bearings from 2 points are better; and bearings from 3 or more points afford a kind of triangulation that is immune from local variance of terrestrial or other magnetism but which is subject to the weaknesses of the 3-point method (Birdseye, 1928, p. 202-205). A rule that should be followed is to use no sight longer in map distance than the needle, if possible. Compass triangulation bearings to three or more points are plotted on transparent paper as lines radiating from a point, and then after shifting this paper on the map until each bearing line

is through the point sighted, the point sought can be pricked through the point on the transparency to the topographic map. Hand leveling from a point on a geologic contact or other point up to a peak or other feature shown by the topography may afford a good location and elevation of the point sought.

If available, advance sheets or photogrammetric manuscripts of the topographic maps should be obtained, for many such sheets are on a larger scale than the published maps, and many show crosses on peaks, useful elevations, shallow prospects, locally used coal beds or mines, fence lines, and other features that are not shown on the published topographic maps.

The aneroid barometer may be used to advantage in establishing the elevation of field stations, especially in a one-man operation. Further discussion of the aneroid can be found in Birdseye (1928), and in the Technical Workbook by the Fuels Branch (1950). If possible, a check barometer reading should be taken on a bench mark or other point of known altitude about once an hour, or a recording barometer should be kept at a central point. Correction curves, constant check of the instrument, and weather conditions are a few of several limitations with which the field man must work.

Plane Table

If no large scale topographic base of suitable scale is available, plane-table mapping of critical areas or areas of good exposures involving mineral beds is the acceptable method to be used in the field. Before starting field work, lay out the land net to scale from measurements on the BLM township plat. Horizontal scale

will be 1:24,000 or 1:31,680. Run traverses in loops and check frequently for closure. Tie all traverses into the land net by locating as many public land corners as you can find. Your instrument man can let you know when you are near a corner. Elevations usually will be determined by plane-table and alidade, but at small isolated outcrops or isolated wells the elevations may be obtained by aneroid barometer.

Errors in vertical control should be kept within 5 feet. Horizontal closure should be within half a scale division (50-feet) within any section. If the error of horizontal closure is plottable, backsight on the corner for correct location. If a consistent error develops, check the magnetic declination, which is subject to local variation. Two or more magnetic north lines may be required for a sheet. If the error lies elsewhere, check the instrument. Convenient references are:

Low, Julian W., 1952, Plane-table Mapping: Harper & Bros., New York, 385 p.

Birdseye, C. H., 1928, Topographic Instructions of the U. S. Geological Survey: U. S. Geological Survey Bull. 788, 432 p. (or its successor).

The geologist should check station numbers with the plane-table man at noon and at night. Each evening the geologist should check the plane-table man's calculations for corrected horizontal distances and for elevation.

Aerial Photographs

General advice on specifications for aerial photographs to meet the requirements of field mapping is given in Chapter II. A brief discussion of some photogrammetric principles that are applicable to

mapping problems follows; a more complete description of methods is presented in the section on "Map Compilation."

Aerial photographs are, in themselves, extremely detailed maps to which one simply adds the geology and other information desired. Distortion in these photographs is rectified by means of high-order stereoscopic instruments or by simple radial triangulation; the results are compiled into the final map. The method used will depend on a number of factors, such as, map scale, accuracy, and the availability of funds, time, photography, stereoscopic instruments, and horizontal and vertical control.

With high-order stereoscopic instruments (Multiplex, Kelsh, or others) one can plot horizontal and vertical positions directly while observing a stereoscopic model. These instruments are usually not available to all offices and the costs for diapositives and field control, which are necessary in their operation, are expensive. This method, however, is extremely accurate.

In the radial triangulation method, a base map is prepared from vertical aerial photographs by means of a templet layout. This map will show picture centers in their true position. Additional points may be located by intersection from picture centers, comparable to plane-table intersection. A radial planimetric plotter provides a simple, accurate, and inexpensive mechanical means of transferring the planimetric detail of the aerial photograph directly onto the base map. Horizontal control is obtained in the field by plane-table triangulation or by the location of land corners. Elevations, if needed, are determined in the field by altimeter or by plane-table method.

Reconnaissance

In general, small-scale reconnaissance-type mapping will be infrequently employed for areas in continental United States, particularly where the area is covered by air photos. It may be used where exposures are poor, or where bedded-type leasable minerals are not present in withdrawn areas. In the absence of photographs or topographic sheets, the Brunton compass and aneroid barometer may be used for detailed reconnaissance mapping. This method, however, is unacceptable for classification of large areas. The decision as to which method is to be used will be made by the Regional Geologist when the project is assigned to the field man.

MAP COMPILATION

General

Although most of the field men in the Branch have either been trained in photogrammetry in school or taken advantage of the Survey's courses on the subject, all can gain additional valuable information from an exhibit book, entitled "Photogrammetric Aids and Compilation Procedures for Geologists," by the Interdivision Committee on Photogrammetric Techniques in Geology (1956). The book, which was prepared to illustrate graphically some of the most promising types of equipment, materials, and techniques that have been considered by the Committee, is not for public inspection but may be consulted by Survey personnel in the libraries at Denver, Menlo Park, and Washington. The following condensation of the introductory paragraphs to several topical divisions of the exhibit book is presented here to afford an idea of the more comprehensive

treatment that these subjects receive in the book.

Aerial Photographs

Even though the science of photogrammetry is relatively youthful, the variety of types and scales of aerial photographs is extremely large. Every geologist should be able to find at least one type of photography that can aid him in this work, and it is conceivable that he may profitably use more than one type. Six different types of photography are as follows:

1. High-altitude photography (flight altitude greater than 20,000 feet above ground).
2. $8\frac{1}{4}$-inch focal length photography.
3. 6-inch focal length photography.
4. Twin low-oblique photography (horizon not visible).
5. Orthophotographs.
6. Color photography.

Photogrammetric Equipment

Since the aerial photograph captures and records in a precise, geometrically correct fashion much of the quantitative and interpretative data relating to the earth's surface, the geologist is turning more and more to photogrammetry, the science of making reliable measurements by means of photography, to obtain a superior product. This requires a familiarity with photogrammetric methods and instruments and a knowledge of their limitations.

Most of the widely known photogrammetric instruments are capable of being applied to some of the problems of the geologist who is concerned with field work and map compilation. Some of the instruments are well known, having been borrowed from the topographer. Other instruments have been developed as a result of the exchange of ideas between the geologist and the photogrammetrist. These instruments have one thing in

common: they can be used to make some form of measurement. This measurement is usually distance, elevation, or direction. Geologic mapping also employs these basic measurements as intermediate steps in the solution of some larger problem. Many geologists have been using photogrammetric instruments to obtain measurements such as dips, strikes, thickness of beds, profile elements, and the like; measurements, heretofore, largely made on the ground. A few geologists are combining aerial geologic mapping with contouring by photogrammetric methods to develop structure contours in geologically favorable terrane.

Aerial and terrestrial cameras, stereoscopes, stereoscopic plotting instruments, and related photogrammetric devices are among the most useful tools the geologist can have, although their full potentialities are not widely utilized or appreciated at present.

Stereoplotted Grid

The stereoplotted grid of David Landen (originated in 1954) enables the field geologist to relate geology from photograph to map, when he has no photogrammetric plotting equipment. It is useful as a field compilation method in which each day's work is compiled as completed. It is best suited as a field compilation method where there is a large correlation between geology and topography, and where the photographs show significantly more than the topographic base.

The stereoplotted grid is a systematic means of organizing the perspective of the photograph and the orthographic projection of the map by means of precisely plotted grids. The lines which appear monoscopically in a stereoscopic model can, however, be stereoplotted.

A Kelsh plotter is used to transfer the lines to the topographic base. The straight lines, because of tilt and relief, become curved lines on the map.

Grids can be prepared by almost any orthographic stereoplotting instrument including the "paper-print" machines. Stereogrids may be prepared in areas where maps are not yet available so that a geologist could construct his own planimetric map in the field. In areas of sparse control, the stereogrids may be assembled as slotted templets, bridging over uncontrolled areas, to reach control.

Grid lines may be placed on planimetric, as well as topographic maps. Grids may also be made in controlled or uncontrolled areas. Distinctive colors are used to separate grids which overlap. An indexing system, letters in one direction and numbers in the other, is helpful in establishing correlation.

Compilation Procedures

The geologist should select the most suitable procedure for transferring geologic data marked on vertical aerial photographs to map bases. The suggested procedures are based on the assumption that accuracy within 1/25-inch in position is desired and that an adequate base map or control is available. For maps of an area within which geologic contacts cannot be accurately located, or for maps wherein position accuracy is not a primary requisite, other procedures simpler than those suggested, such as visual inspection and direct plotting on aerial photographs, may be found satisfactory.

In all cases in which the paper prints are to be used in compilation of data it is important that Air Map Special paper or other

suitable stable-base or uniform-shrinkage material be used. The procedures are primarily designed for use of so-called vertical aerial photographs. However, in most of the procedures transformed prints or properly oriented diapositives of low oblique (Twinplex) photographs may also be used.

The greatest economies in time and effort may be obtained by using photographs of the smallest acceptable scale. It is therefore recommended that careful consideration be given to, (1) selecting aerial photographs of small scale for use in the field, and (2) use of even smaller aerial scale photographs in the compilation of the map then were necessary for mapping in the field.

Cartographic Materials

The choice of materials that can be used in compiling or drafting a geologic map is large. Materials are available that have one or more of the following characteristics: stability, transparency, ability to take ink or pencil, stiffness, and flexibility. Certain of these materials that are excellent in many ways may also have one serious weakness such as a tendency to deform at moderately high temperature. The processes by which a selected material may be overprinted are many. The kind of copy it makes when photographed is important.

Many man-hours of labor in transferring and copying for compilation, or inking and scribing for reproduction may be saved if careful consideration is given at the beginning of a project to selecting a base for cartographic work that satisfies the requirements of field work, compilation, color separation, and reproduction. A section on

this subject in the exhibit book prepared by the Interdivision Committee on Photogrammetric Techniques in Geology, 1956, gives examples and describes the advantageous characteristics of many materials now available for use.

The selection of material for one project might turn out to be the best, while use of the same material for another project might be a serious mistake. The Branch of Technical Illustrations (see figure 1) will advise on this subject when requested.

Scribing Techniques

Scribing techniques that involve the graving or scribing of coated plastic sheets are now being used in certain phases of topographic and geologic mapping, and are bringing about many improvements in the preparation of maps for reproduction. One of the principal advantages of scribing in field compilation is that clear copy may be obtained by reproduction processes regardless of the number of times the geologic data shown in pencil or ink on the plastic coating has been altered. Copies can be prepared economically by simple contact reproduction techniques.

Information is available on a variety of methods employing scribe-coat material that can be adapted to geologic mapping.

Some of the newer methods for transferring geologic data from photograph to map utilize dimensionally stable photographic material in the preparation of diapositives for use in double projection stereoplotting instruments.

Topographic and geologic maps are prepared for publication by scribing techniques. Scribing techniques are also being used within the

Topographic Division for the addition of data obtained in the field completion phase. Similar techniques may have future application in some projects involving geologic mapping. The use of a transparent material such as Mylar, or opaque material, such as metal-mounted sheets, is preferred for field geologic manuscripts at this time.

For further details on the process as used in the Topographic Division, see the preliminary draft of their "Instructions for Color Separation Scribing," dated June 1956 (for new Manual of Topographic Instructions - see bibliographic reference, Birdseye, 1928).

SAMPLING AND ANALYSES

If insufficient analyses have been made previously of the leasable mineral from the area being mapped, properly collected samples, described as to location, should be obtained for that purpose. A form for requesting analyses from the Geochemistry and Petrology Branch is available.

When needed, samples of bedded-type leasable minerals should be collected wherever sections are measured. These points are usually spaced close enough to indicate the continuity or lack of continuity of the bed. Depending on thicknesses, variations in mineral content, and accuracy desired, samples may be taken every one-half mile, or less, or as much as $1\frac{1}{2}$ to 3 miles apart; in some extreme cases, 6 miles apart. Data in the table that follows will serve as a guide in the spacing of samples to be collected from bedded deposits of leasable minerals; actural spacing is left to the geologist's judgment:

Mineral	Spacing of Samples
Coal	$\frac{1}{2}$ to $1\frac{1}{2}$ miles.
Phosphate	1 to 6 miles
Potash	$\frac{1}{4}$ to $\frac{1}{2}$ miles.
Oil shale	$\frac{1}{2}$ to $1\frac{1}{2}$ miles.
Sodium	$\frac{1}{4}$ to $\frac{1}{2}$ mile.

The following weights of samples should be sent to the laboratory indicated:

Coal 1/ - 1 pound unweathered, air dried sample if mechanically crushed, or 2 pounds if hand crushed. Send to U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa., or to the Geochemistry and Petrology Branch.

Phosphate 2/ - 1 pound sample to Geochemistry and Petrology Branch.

Potash 2/ - 1 pound sample to Geochemistry and Petrology Branch.

Oil Shale 2/ - 1 pound to nearest Bureau of Mines Experiment Station or to Geochemistry and Petrology Branch.

Sodium 2/ - 1 pound to Geochemistry and Petrology Branch.

1/ See Snyder, 1957.

2/ See Instructions for preparing and submitting requests for analyses in Manual of Laboratory Services, by Geochemistry and Petrology Branch, 1956.

A procedure for collecting channel samples of coal for analyses or tests to be performed by the Bureau of Mines is given in the Appendix.

MEASUREMENT OF SECTIONS

Measure stratigraphic sections containing leasable minerals as needed to obtain knowledge of stratigraphy and show any facies changes. Record thicknesses in feet and preferably down to inches. The measurements may be obtained from outcrops, trenches, mine workings, and drill holes.

FOSSIL COLLECTIONS

Collections should be kept separate, bed by bed. Each locality should be given a station number and should be shown on the appropriate map. The interval in the bed from which the collection was made to a formation boundary or to a marker bed should be measured. A sample form for requesting identification of fossils by the Paleontology and Stratigraphy Branch of the Geologic Division of the Geological Survey is enclosed in the pocket of this manual. Reports on collections are to be kept in the paleontology file in the respective field office, but duplicates or copies may be kept with the project notes.

SPECIAL EXPLORATION METHODS

Exploration by use of a power auger where possible may be justifiable in areas with few or poor exposures or where subsurface data are not available. Otherwise, samples may be obtained with a coal auger operated by hand. In the case of phosphate, trenching with a shovel or bulldozer may be necessary.

SUBSURFACE INFORMATION

Subsurface information should be obtained whenever possible. A large part of these data will consist of logs of stratigraphic tests, logs of seismic shot holes, and occasional cores, obtained mainly from oil companies or mining companies.

MISCELLANEOUS

For a description of features to be shown on township plats see section "Preparation of Township Maps" in Chapter IV - Record Data Preparation. Most of the culture can be taken from aerial photographs but should be checked in the field. Be sure to mark the

location of all accurately determined mineral exposures, stratigraphic sections, sample collections, and fossil collections on township maps. For other information to be secured, see Chapter IV.

CHAPTER IV

CHAPTER IV. -- RECORD DATA PREPARATION

INTRODUCTION

General Purpose Maps

One of the objectives of general purpose geologic mapping is to provide quadrangles contributing to the geologic map of the United States. Results of any additional special purpose mapping necessary during this field work will provide the basis for classification of lands for leasable minerals. General purpose geologic maps will not be discussed in this manual because they are described and illustrated adequately in memorandums and publications by the Geologic Division (see Chapter III).

Although field work for general purpose geologic mapping is on topographic quadrangles, the largest unit of the public land system is the township. The township is therefore adopted as the unit for all reports on classification, except when delineation of parts of several townships on one map will enhance the clearness in cartographic presentation and in written description.

Special Purpose Maps

In connection with classification work, field men will submit, as a detailed record for each township examined, maps and descriptions of their observations that relate to the general and economic geology. This applies particularly to minerals other than oil and gas. Where oil and gas fields or structures are involved, the primary consideration is the structure contour map. Structure contour maps may affect one or more townships. The original data should be complete in every particular, for they serve not only as matter of record but also have various other important uses. For example, if reclassification

is necessary on account of future changes in regulations or standards, these data will form the basis for such reclassification. An important present use made of the data is in answering inquiries from the Bureau of Land Management, the Bureau of Indian Affairs, the Bureau of Reclamation, and the Department of Health, Education and Welfare, relative to the mineral character of designated areas, wherein proper action depends largely on the completeness of the information submitted by the field geologist. The geologist should acquaint himself with the needs involved in replying to these queries by conferring with some member of the Branch familiar with the subject, for only by so doing can the necessity for completeness of the record be appreciated.

Exceptional cases will be discussed in conference between the field geologist and the Branch Chief or the particular classification board, or its representative, before preparation of the record data, and the geologist will conform to the ruling of the board. In general, therefore, each report will deal with a single township and will be complete, if possible, within itself, although where geologic conditions are similar to those in an adjacent area, repetition of descriptive matter may, if the board approves, be avoided by cross-reference. Where field work has been done by topographic quadrangles, a composite township map from cut-outs of quadrangle sheets may be substituted. All features which can be shown graphically should be so shown, and descriptions should be restricted to those things which cannot be shown on the township maps.

Dam site and reservoir investigations made for the Branch of

Waterpower Classification ordinarily do not cover whole townships. These are also special purpose geologic maps, and township reports are not required for this work.

PREPARATION OF TOWNSHIP MAPS

General

Maps submitted should normally be in the form of reproduced copies on a topographic base, or on a plane table base if no topographic coverage is available. Any suitable reproduction process on white paper should be used, but preferably one giving dark lines, not blue prints, for example, in township units of the compiled economic map, on a scale of 2 inches to a mile. 1:31680 An areal geologic map should be submitted showing the structure of the field or area, contour interval 20 feet, or separate areal and structure maps dependent on the scale and the amount of control and relief; and a map to serve as an index of the entire area covered, including the township involved, should also be compiled and submitted. In township maps, variations from the usual scale of 2 inches to a mile may be employed if the prescribed scale is undesirable, but such variations must first be approved by the board. Where the field geologist desires to submit original field sheets or copies of same, such action must also have the authorization of the board. The scale may be larger than 1:31,680, depending on the availability of topographic or photographic coverage and the complexity of the geology to be shown.

Information to be Developed and Recorded by Townships

The maps finally submitted for a township should show the following data or should be accompanied by the following information:

1. Formation boundaries or contacts of mappable units.

2. Outcrops of leasable minerals, such as coal, phosphate, or other minerals; the associated formations; and any marker bed mapped using solid lines where known, and broken lines where inferred.

3. Geologic sections as needed for the clarification and interpretation of the maps and for showing subsurface data may be on a separate sheet.

4. Location of any prospects, mines, drill holes, core or oil and gas tests, not shown on the topographic sheet with:

   (a) Names of mines and their elevation at the collar of the shaft, tunnel opening or adit.

   (b) Outline of area worked for prospects and mines.

   (c) Surface elevation, casing head, or rotary table elevation, total depth, deepest formation tested by wells drilled for oil and depths to producing sands.

   (d) Ownership and diameter of oil and gas trunk pipe lines.

   (e) Lease ownership as part of special purpose geologic mapping.

5. Detailed columnar stratigraphic sections showing leasable mineral beds should accompany maps, including several representative sections to be shown graphically on the map, if possible, on a scale of 200 feet to an inch, or other suitable scale, each section to be accompanied by

notations indicating the character and thicknesses of the parts differentiated. For example, phosphate, 10 inches; sandstone, 2 inches; and shale, 4 inches. If all sections cannot be shown on the face of the map, they are to be described in the accompanying text, or may accompany same in graphic form. If drawn on the map, the sections should not obscure the outcrop line, but should be drawn as near these lines as possible, and should be connected with the position of the sections by rays. If these graphic sections would obscure other important features when drawn on the map, they should be drawn on an overlay.

6. Analyses associated with stratigraphic sections should be shown, indicating from what part of a bed or deposits each sample was taken.

7. Structure contours drawn on a key bed or on important beds of leasable minerals. The degree of inclination of the strata will govern the contour interval to be employed. For example, for a 60° dip, only the depth limit for classification of the particular mineral and the minus 6,000-foot contour need be shown. For lesser dips the contour interval should be 20 feet or less, and the interval to be employed should be decided upon by the geologist in charge. In the case of an oil and gas field or structure the contour interval selected will be that best suited to represent the structure, whether the map is the

result of surface or subsurface work.

8. Isopachous and other special maps. Where isopachous maps will aid in the interpretation of structure, depths of over-burden, or thicknesses of leasable minerals, they should be included in the data submitted. This would also apply to maps showing oil sand distribution or other variations in sedimentation.

9. Dip-and-strike determinations and axial lines of anticlines and synclines.

10. Other geologic features that may affect the value of the leasable mineral deposits, such as, dikes, thin cover, and cutting out of deposits by unconformities.

11. Features to be differentiated:

    (a) Mines and prospects made before field examination (state in the text when and by whom opening was first made if this information is readily obtainable).

    (b) Prospect holes or pits dug by the geologist in the course of the examination. Differentiate from (a) by affixing initials of the Chief of the Party. This differentiation of prospects is very important in connection with inquiries from the Bureau of Land Management relative to what knowledge an entryman should have had at the date of final proof.

12. Use of colors and symbols. Information regarding leasable minerals should be indicated by symbols in a distinctive color or colors on the map submitted. Formation boundaries,

faults, dips, and strikes, and all lettering relating directly to geology should be in black. Structure contours are to be shown in red. All information showing culture, mines, prospects, quarries, wells, drill holes, sections and their position, outcrops, streams, drainage, and topography should be represented by the symbols and colors adopted by the Geological Survey.

13. Distinguish geologic formations. On the submitted township maps the various geologic formations should be distinguished by colors, using the uniform color scheme of the Geological Survey. Care should be taken that the colors used do not obscure other data. If only one formation is exposed in a township, the map need not be colored, but the formation name should be stamped or written clearly thereon by use of standard Survey map symbols.

Structure sections should be colored to correspond with those shown on the map. The explanation on the maps and sections should give thickness, lithology, age, and intervals between beds. If different colors of ink are used to indicate outcrops of different mineral beds, a corresponding color should be used in the columnar and structure sections. Judgment should be exercised in selecting the scale for a columnar section, for it should be small enough to allow for proper delineation of the stratigraphic intervals in only 12 inches of space. Columnar sections may be broken for thick, nonmineral

strata, but the thickness of these strata are to be indicated.

14. By reason of the greater depths to which coal and other minerals are being stripped, opinions should be recorded on the possibilities of stripping any area mapped, bearing in mind that coal is now being stripped in Pennsylvania with a six to one stripping ratio to a maximum depth of 400 feet. In the rich oil shale (25 gallons or more) area of Colorado it has been proposed to mine by open-pit methods with as much as 1,000 feet of overburden where there is little or no folding. Where areas favorable to stripping are found, such areas should be outlined or clearly designated on the map in order to bring them to the attention of the classifier and the Branch of Mining Operations. In all cases the depth of overburden and the stripping ratio for any solid leasable mineral should be mentioned in addition to any other factors bearing on the practicability of stripping operations in the area. A check list which may help in connection with field descriptions of coal beds is given in the Appendix.

Maps Not Compiled on Topographic Base

Maps not compiled on a topographic base may include planimetric maps and oil and gas structure maps. For mineral classification purposes they are frequently compiled from plane table sheets when a topographic base is not available. The plane table sheets or maps should

include all the information enumerated in the foregoing paragraphs regarding maps on a topographic base except that topographic contours are not required on plane table sheets. The oil and gas structure contour map may be either a surface or subsurface map. It is usually compiled on a base of 2 inches to the mile or on the scale of available development maps. Maps of these types are not intended as contributions to the geologic map of the United States or for quadrangle publication.

The plane table sheet or map should also show:

1. Any land corners not shown on topographic sheet.
2. Mines or prospects.
3. Prospect holes or pits.
4. Lease ownerships and operators.
5. Land corner symbols. On the map show land corners in black as follows, each symbol to center the location of the corner:
   (a) Government corners found, by standard topographic map symbol.
   (b) Doubtful Government corners, by a circle and cross therein.
   (c) Corners shown on railroad or topographic base map, but not visited, by a square.
   (d) Privately established corners, by a diamond.

Section and lot lines are to be drawn in black, using full lines where surveys actually exist, broken lines where the lines are projected across unsurveyed or

unsatisfactorily surveyed areas. The accompanying description should contain a detailed statement of the basis for such projections. All the lots and sections should be numbered in accordance with the latest BLM township plat. The smallest legal subdivisions (lots or 40-acre tracts) should be shown. In the text reference should be made to any discrepancy that may exist between the subdivisions shown on the plat of the Bureau of Land Management and those of the record-data map.

Identification of Mapping

All maps including plane table sheets for township maps must bear:

1. Name of person in charge of party.
2. Diagram showing area covered by each individual.
3. Dates when field work was done.

PREPARATION OF TEXT

Although the township maps should show graphically all information that can be readily illustrated, their real value for classification will be enhanced by a well written text, and should be so supplemented. Reference to the classification standards for the mineral or minerals involved will indicate the information needed in the text for classification purposes.

In order to assure that information needed will be supplied, and to prescribe the order in which this information is to be presented, it is directed that so far as practicable the material should be in accord with the following outline:

1. Title. Give the name of the area. State if surveyed

or unsurveyed. Where only a township at a time is discussed, head the paper in the following form:

T. 11 N., R. 115 W., 6th P.M., Colorado

2. Method and dates of field work. Give a brief statement.

3. Cadastral surveys. Give the dates of the surveys involved, describing any differences that may exist between the land net used and the plat of the Bureau of Land Management.

4. Geographic position. Give the county and state and the nearest town. If the township is not crossed by a railroad, make reference to the geographic relation of the township to the nearest rail line. Refer also to highways if they would effect transportation conditions with respect to the township. In extremely isolated areas the latitude and longitude may suffice.

strat + struct,

5. General geology. Discuss briefly the stratigraphy, structure, topography, and land use of the area. Give detailed stratigraphic sections of the rocks exposed in the township. Geology should cover a general description of the formations exposed, nature of exposures, marker beds used, correlation problems, and subsurface stratigraphy. Information on structure should cover the relationship of the area to major structural features; regional dip, structure, relief, local details of structure.

6. Stratigraphic sections. Describe all measured sections of leasable minerals, or observations on them that are not

fully presented on the maps, and identify all such sections or observations by cross-reference on the map.

7. Leasable mineral deposits, including oil and gas. Discuss all deposits of possible economic value occurring in the township, whether they have been fully prospected or not. Give briefly the physical characteristics of the mineral deposits and the results of chemical or other analyses, connecting by cross-reference the sample analyzed with the place of occurrence on the map. For example, in the case of exposures of coal, oil shale, or phosphate give the number and thickness of beds, a general statement as to the extent of the beds, and a detailed description of each bed, including its character and quality, variability, and the presence of partings. This should be supplemented by detailed measured sections of the beds containing leasable minerals, and by photographs of such sections to show their stratigraphic relations. Similar information should be included on oil and gas deposits, giving such data as thickness, porosity, permeability, quality of oil, and other reservoir information.

8. Mines and prospects. Discuss mineral production by individual prospects and mines, giving the date of the first opening, the name of company or party opening the mine, their post office address, an estimate of the quantity of the mineral removed, and the names of the persons interested in the property. Data on active as well

as inactive and abandoned mines should be included.

9. References. Give references to published reports on the area treated. It should be borne in mind that negative evidence is almost as valuable as positive data. For example, where the formations underlying a township bear neither coal nor phosphate, do not leave that fact to inference but state specifically that the strata appear to be barren of such deposits. Likewise, if any zone which contains coal or phosphate in other localities within the region is found to be absent, or to contain no commercial deposits, record that observation both graphically and in the written description.

10. Non-leasable minerals. Many inquiries for classification or information from the Bureau of Land Management relate to the mineral character of public land other than its value for leasable minerals. In the description of a township, therefore, statements should be made about all mineral deposits of present or possible future economic value, including special clays, building-stone, gypsum, iron, and gold.

11. Signature and date. All township reports should be signed by the person preparing them, with his title, and should bear the date of transmission to the Washington office.

CONFIDENTIAL DATA

No data of a confidential character should be shown on the map, but in all cases where sections, drill records, or other data are

confidential, the position of the hole or test pit should be shown on the map with the word "Confidential" (abbreviated where necessary), and with a reference number which will agree with that in the accompanying text. All confidential material including well logs should be kept separate from the general description, and should be submitted separately and headed "For United States Government Use Only," in accordance with the Departmental Manual (442.7.1). The files of the Regional Mining Supervisor, and the Regional Oil and Gas Supervisor are open at all times to the Regional Geologist and his authorized staff for consultation, including maps, well logs, reservoir data, and assays. Such information should not be made public without first obtaining clearance through the supervisor.

Minutes

CHAPTER V

CHAPTER V. -- CLASSIFICATION

Page

INTRODUCTION

Activities of the Branch center around its main function, the classification of public and acquired lands for their mineral value. Classification is here used in a broad sense, being any determination and report concerning mineral value made by the Branch. The various types of reports prepared by the Branch, sources of requests for the reports, and disposition of the reports are indicated in the chart shown in figure 5. Classifications are of two types: formal and informal. The responsibility for both classifications rests with the Washington office unless specifically delegated elsewhere.

Formal classifications are based on explanatory written minutes stating the geologic basis for such actions; when completed, the plats or orders showing such determinations are finally approved by the Director, or Acting Director, of the Geological Survey. Formal classifications involve the determination, for each of the leasable minerals, as to whether the land under investigation is valuable or not valuable.

The leasable minerals are: oil and gas (including all natural gases, such as, carbon dioxide and helium), coal, phosphate, sodium, potassium (potash), oil shale, sulphur (New Mexico and Louisiana only). Asphaltic minerals (solid hydrocarbons) have been considered for leasing, and one withdrawal of asphaltic minerals is in effect (Utah and Colorado), but no leasing provisions have yet been established which are generally applicable to their exploitation (43 CFR 102.19, 152.7). However, provisions for asphalt leasing of certain lands (formerly Indian lands) in Oklahoma have been made under a special

law, Act of June 28, 1944 (58 Stat. 463, 483-485). The leasing of silica and other nonmetallic minerals in Nevada on lands withdrawn by Executive Order No. 5101 of May 3, 1929 has been authorized by the Act of May 9, 1942 (56 Stat. 273) as amended by the Act of October 25, 1949 (63 Stat. 886).

In their final form, as signed by the Director or Acting Director, the plats or orders are publicized and made available for public inspection. Such actions, which are based on adequate mapping and field investigations, will be undertaken in the future on areas involving public lands that are now included in outstanding mineral withdrawals, areas that should be reclassified because of new information or changes in classification standards, and areas not previously included in any withdrawal. A formal classification as mineral land, requires in disposal of the land by the land office, the automatic reservation of the leasable minerals involved.

Informal classifications comprise all other determinations, whether written or oral, that do not involve the preparation of minutes or plats for approval by the Director. Each determination should be made carefully; however, -- a written informal determination can obviously be more readily and expeditiously revised than a formal determination. Informal classifications include undefined known geologic structures of a producible oil and gas field or area, additions to an approved known geologic structure, reports on surface applications for homesteads or other nonmineral applications submitted to the land offices, reports to the Federal Power Commission on dam and reservoir sites, and an occasional areal report to the Department of Defense.

Informal classifications are normally made in reply to requests from other agencies as to specific tracts of land, whereas formal classifications cover areas, generally by township or field, and are initiated by the Survey.

CLASSIFICATION STANDARDS

Classification standards applying to leasable minerals have been established for field and office use through library research by members of the Washington staff, conferences with and reports from field men of the Branches of Mining Operations and Oil and Gas Operations, through discussions with representatives of industry, and through criticism, memoranda, and reports by additional members of the Geological Survey and members of other bureaus.

Experience gained by mapping and by operations under the Leasing Act of February 25, 1920, has broadened the knowledge of the occurrence of the leasable minerals. Since the original regulations or standards were published in 1913 (Bull. 537) for classification of coal, oil and gas, phosphate, and potash, great strides have been made in technology, and it is expected that advances will continue to be made in the future. Changes in the utilization, mining, and preparation of minerals and other economic factors affect the exploitation of the leasable minerals. It seems prudent therefore to investigate periodically -- every five years at the most -- the adequacy or applicability of the classification standards and regulations in effect.

The standards are intended to express the broad principles of classification to be applied to any lands that are in outstanding withdrawals in addition to those Federal lands that are not withdrawn

but which may contain the leasable minerals. They are for the guidance of geologists of the Branch of Mineral Classification as well as other members of the Geological Survey who may map areas containing leasable minerals.

Before undertaking actual field work preliminary to formal classification, personnel should become familiar with the classification standards for the mineral deposits to be mapped or for which field investigation is to be performed. Reference should be made to U. S. Geological Survey Bulletins 537 (1913), and 623 (1917), for the background of classification work. The early classification standards for leasable minerals will be found in Bulletin 537 and the recent standards in the later-approved minutes of the classification boards are in Chapter VII of this handbook. Copies of the minutes will be found in the regional field offices of the Branch of Mineral Classification, and additional copies may be obtained by the authorized personnel on request.

PART A -- FORMAL CLASSIFICATION

The sequence of actions that take place in formal classification of lands for minerals other than oil and gas may be summarized as follows:

1. Preliminary investigations or receipt of information indicating the presence of possibly valuable deposits of leasable minerals.
2. If not already withdrawn, formal withdrawal of lands involved for purposes of classification will be made on recommendation to the Bureau of Land Management.
3. Adequate field investigation and mapping to determine

size and character of deposits.

4. Preparation of reports, map, and the proposed mineral classifications of the lands, with accompanying board minutes.
5. Consideration of each proposal by the appropriate classification board for approval of the minutes, and its explanation of the classification or other action taken.
6. Preparation of final classification plats and orders and the necessary memoranda of transmittal for the approval of the Director of the Geological Survey.
7. Following the Director's approval, distribution of copies of the classification action, together with the preparation of a memorandum requesting that the Bureau of Land Management take steps toward restoring any lands that had been formally withdrawn and which have now been classified.

Formal classification will usually be performed in the Washington office following receipt from the field of township record data and maps based on actual field investigation; the material is to be in the form desired by the Branch. See Chapters III and IV of this handbook for detailed information on the preparation of the background data. Exceptionally, the field geologist will be consulted by the classification board concerned for available data in advance of compilation, in order that any specially urgent classification of limited areas may be made.

Submission of Classifications to Boards

General

The proposed classification shall be initiated by the field

geologist, if so designated, or by the Washington office geologist as a member of a board, who shall prepare a set of minutes comprising a summary of the geological information applicable. The minutes will be supplemented by explanatory visual material (maps, charts, and similar data) as necessary. Using record data and all other pertinent information available, he shall apply the approved classification standards or regulations for the leasable mineral involved. All textual matter shall be typewritten (minutes and supplemental reports) for presentation to the appropriate classification board and shall be on letter size paper (8" x $10\frac{1}{2}$"). The left hand margin of all typewritten material shall not be less than $1\frac{1}{2}$ inches wide.

The proposed classification shall be made by smallest legal subdivision (40-acre tract, or surveyed lots) and, shall be indicated on preliminary township plats, form 4-398a or an approved modification thereof. These preliminary plats shall show withdrawn areas, areas to be restored, if any, and the classification made, with sketch lines showing applications of radius determinations, for example.

All township reports and minutes shall bear the name of the state, township, range, and meridian, and the number of each page (except page 1) is to be centered at the bottom. The title of the minutes shall be shown as on the sample of minutes included in this handbook.

The individual or individuals preparing the minutes, or classifying the land, will endorse the minutes and place their initials at the bottom of each classification plat, near the left-hand margin of the page.

One copy of each township report is to be supplied to the board. Three copies of the minutes shall accompany the reports, one on heavy paper for the Washington office files and two carbon copies on thin paper, one for the District Geologist and the other for the Regional Geologist.

The proposed classification shall be reviewed by all members of the board. A board may meet in Washington or in the field, and will have the benefit of consultation with other members of the Conservation Division, with members of the Geologic Division, or members of any other divisions in the Geological Survey, as well as with members of other bureaus that are particularly interested in or have expert knowledge of the problem in hand. When the board has passed upon the proposed action, it will show its approval by appropriate signature following the minutes, whether as submitted initially or as revised by the board.

Outlines for, and samples of, coal and oil board minutes are presented in this chapter, together with further discussion and explanation of actions to be taken.

Introduction

How the proceedings of the various land classification boards were conducted prior to July 1, 1925, is not clear from the records. Results of their deliberations were recorded in a set of "minutes" that provided the basis for the classifications made by the boards. The boards also made recommendations as to the restoration of classified lands to the public domain.

Evidently, in order to formalize the proceedings, minutes were

prepared on legal-size paper and signed by the geologists involved. The format has been retained because it provides a record in each instance of the manner in which the so-called board reached its conclusions. In the record the geologic basis is readily available for the classification made. A guide to leasing is provided by the record; it also contains data useful in answering any appeals filed subsequently by homesteaders or by others who might wish to set aside the classification. The legal aspect of the proceedings has been retained by the Branch, to prevent any loss of leasable minerals. Examples of the more recent methods of preparing minutes follow; the first method described is that used by the Coal Board.

Classification of Solid Leasable Minerals

Preparation of Minutes of the Coal Board

These Minutes of the Coal Board are prepared in accord with the sample (Minutes of the Coal Board, September 28, 1940, Coal Resources of McCone County, Montana) at the end of this section, which is offered as a guide for the discussion of the geology of the area mapped and for the coverage of each township in the classification.

The minutes shall conform with the outline that follows this paragraph, which outline may be used for all leasable minerals except oil and gas. Discuss in detail the geologic occurrence of the particular mineral with regard to the approved classification standards. Although final classification may be performed in Washington, the classification standards in Chapter VII must be consulted before attempting to map any land for classification purposes.

OUTLINE

1. Introduction.

    Discuss the general area involved in the classification, mention withdrawals and restorations with dates and the publications and reports used as a basis for classification.

2. General geology of area under consideration.

    Areal geology

    Structure

    Coal beds

        Number and occurrence of each

        Thicknesses

        Depths

        Quality -- heating value (BTU), air-dried sample

3. Geology of each township (give separately).

    Cite withdrawal affecting the lands

    The coal stratigraphy

    Describe lands classified as coal) by legal subdivisions,
) (40 acres, tract or lot)
    Describe lands classified as noncoal)

    Recommendation by the Board that lands be restored or that no action be taken by reason of prior classification and restoration, or for other reason.

4. Preparation of township plats (form 4-398a or revision thereof).

    After completion of discussion of the general geology of the area, and of the structure and stratigraphy of each township, prepare township plats (form 4-398a

or an approved modification thereof) showing the classification by legal subdivisions or tracts. Indicate such classification after close inspection of the areal and structural geologic maps for the township involved; in the case of coal, for example, by approximating the crop line of unburned coal as one of the limits of the classified area. The depth of classifiable coal would be the other limit.

Sample Minutes of the Coal Board

General Report MONTANA C-594

Minutes of the Coal Board [1]

Date: September 28, 1940

Subject: The Coal Resources of McCone County, Montana

Present: Northrop and Miller with M. M. Knechtel in consultation. (include mining engineers in consultation if necessary)

The townships involved and considered for classification range from T. 16 N., to T. 27 N., Ranges 41 E. to 50 E., M.M., Montana, within the borders of McCone County, Montana. All these lands were included in Coal Land Withdrawal Montana No. 1, approved July 9, 1910. A limited number of the townships within this county have been classified previously wholly or in part, and these areas are not in outstanding withdrawal. Such lands were included in Restoration No. 68 of March 27, 1918, in Restoration No. 78 of July 24, 1922, and in Restoration No. 82 of April 21, 1924. Parts or all of some of the townships along the south side of the Missouri River which forms the northern boundary of the area under consideration were not withdrawn as such townships were affected by classifications prepared for the Indian Office on January 18, 1912, involving lands in the Fort Peck Indian Reservation.

The basis for Board action consisted of the published report on the area, Bull. 905, the Coal Resources of McCone County by Collier and Knechtel, the individual township reports containing the results of field examinations by Thom and Woodring in 1919, by Dobbin in 1922, by Erdmann in 1927, and by Collier and others in 1927, 1928, and 1929, who re-examined the portions formerly mapped. Knechtel made no field investigations in this county but compiled the field notes and wrote the report under Collier's direction. A discussion of the coal possibilities of that portion of the county immediately south of the Missouri River between T. 25 N., and T. 27 N., Ranges 43 E. to 50 E., was included in an earlier report, the Fort Peck Indian Reservation Lignite Field, Montana, Bull. 381, p. 40-60, by C. D. Smith.

---

[1] Not a complete copy

According to Knechtel, McCone County lies in the Missouri Plateau section of the Great Plains geomorphic province, and the general slope of the land surface is northward toward the Missouri River. The Sheep Mountain divide between the Yellowstone River and Redwater Creek extends northeastward across the southeast corner of the county, and the Horse Creek divide extends north-northeastward across the middle of the county between Redwater Creek and the Missouri River. The northern one-third of the area extending to the Missouri River "breaks" or flood plain is occupied by the Iowan or Illinoisan (?) ground moraine. The total relief of the county is a little more than 1,300 feet.

The structure contour map, plate 9, Bull. 905, shows a general southeastward dip in the northern two-thirds of the county toward a syncline which is considered by Dobbin and Erdmann (Structure Contour Map of the Montana Plains) a part of the Sheep Mountain syncline, extending east-northeastward across the county. The total structural relief is about 1,100 feet and the dips toward this syncline are ordinarily so gentle that the strata are said to appear horizontal. The southeastward dip is interrupted by a fault near Weldon striking northeastward from T. 19 N., R. 43 E., to T. 21 N., R. 45 E. The throw of this fault is probably between 100 and 160 feet, and the downthrow side is on the south. This displacement results in a monoclinal flexure.

Coal found in what is thought to be the Colgate member of the Fox Hills sandstone (?), Cretaceous, was observed at two localities but is thin and valueless. Lenticular coal occurs in the Hell Creek member of the Lance formation, Eocene (?), according to Bull. 905. This member has recently been raised to the rank of a formation and has been determined to be of Upper Cretaceous age instead of Eocene age, and to belong in the same geologic period as the Fox Hills. Collier and Knechtel have designated the coal beds alphabetically, ending with the lowest or bed Z in the Hell Creek formation.

The coal beds in the Tertiary, beginning with the oldest, occur in the Tullock member of the Lance formation and in the Lebo shale and Tongue River members of the Fort Union formation according to Bull. 905. These three coal-bearing members have now been placed together in the Paleocene series.

The Tullock member (now Tullock formation, Cretaceous or Eocene), contains thin streaks of coal, designated beds V, W, X, and Y, which locally are thick enough to be of economic value. Bed W consists in many places of two benches from 10 to 40 ft. apart. Correlation of these local beds from place to place is difficult.

The Lebo shale member contains few coal beds. At the base is the "Big Dirty bed" designated Bed U in the bulletin. It contains many impurities and is extremely variable in quality from

place to place. Bed T is probably a discontinuous bed or a number of lenses occupying isolated areas in the Lebo shale above bed U, according to Collier and Knechtel.

These authors state (p. 19-21, Bull. 905), that "The most promising coal beds in McCone County are in the lower 400 feet of the Tongue River member, Bed S.... near the base, and bed P, about 350 feet higher, have been traced farthest, but between them several more or less local beds contain coal of value. The coal in bed S is rather persistently of good quality and is generally thick enough to mine .... Not uncommonly the outcrop of bed R .... is split into two benches by a thick parting .... correlation of bed R from place to place is difficult in many parts of its outcrop .... The upper bench of bed R is characteristically impure and valueless, ... The lower bench generally contains more than $2\frac{1}{2}$ feet of good coal. .... Correlation of bed Q is difficult along much of its outcrop in McCone County. Probably the coal mapped as bed Q is not everywhere the same bed but rather a number of lenses at about the same stratigraphic horizon .... The bed is nearly everywhere more than $2\frac{1}{2}$ feet thick. The coal of bed P is variable in thickness but of rather uniformly good quality. It can be traced across the southern part of the county but in the western part it cannot be positively identified north of T. 18 N., ... Bed P appears in general to thin northward. The strata for 500 feet above bed P are almost barren of coal, no coal beds more than $1\frac{1}{2}$ feet thick having been found in them. In the strata between beds P, Q, R, and S occur several coal beds or lenses, which are traceable for only short distances."

In general, the outcrop of Lebo shale containing coal bed U at its base extends diagonally northeastward across the country from T. 19 N., R. 43 E., to T. 25 N., R. 50 E. From T. 22 N., R. 45 E., to T. 25 N., R. 50 E., this bed ranges in thickness from 3 feet to 8 feet and the Board accepted this seeming persistence of thick coal as warrant for coal classification of those lands underlain by this bed only. In addition to bed U lenticular coals are known to occur in the lower 100-ft. of the member. Overlying the Lebo is the Tongue River member containing in its lower 400 feet the principal coal beds of the county, beds P, Q, R, and S. In the strata between beds P, Q, R, and S, several lenticular beds occur. The Board, therefore, decided to confine coal classification mainly to the Tongue River coals except where bed U is known to be clean enough and sufficiently thick to support a classification as coal land, or where beds in the Tullock and Hell Creek formations attain classifiable thickness. The crop line of each of these beds is shown on Plate 1 of Bull. 905.

Collier and Knechtel further state on pp. 24-25 of Bull. 905, that "As the three samples of coal from the neighborhood of Circle .... average about 8,080 British thermal units, and as it is possible that some of the coals in the other parts of McCone County for which

analyses are not available, may give higher heating values, 2 feet 6 inches has been chosen as the minimum thickness for valuable coal beds...."

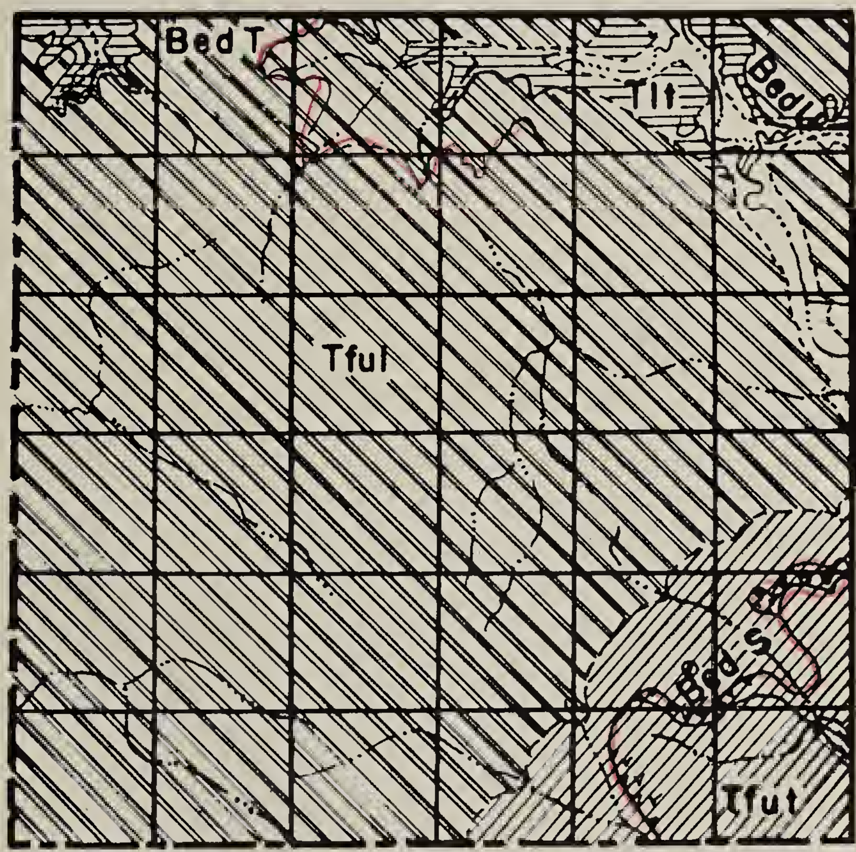
The coal of beds T, V, W, X, Y, and Z is extremely variable in thickness and quality, ... Beds P, Q, R, S, and U, however, are fairly persistent in both thickness and quality,...."

Although the authors publish only three analyses of Tongue River coals, i. e., bed P: 7,840 B. t. u., local bed: 8,170 B. t. u., and bed R: 11,000 B. t. u., the Board accepted their statements and these analyses as sufficient warrant for an assumption that all Tongue River and Lebo coals in an unweathered state possess a heating value of 8,000 B. t. u., or more air dried. This corresponds to a minimum minable thickness of 38 inches, and a miniumum depth limit of 500 feet. A sample from the lower bench of bed R collected by C. E. Erdmann from a strip mine in sec. 32, T. 19 N., R. 48 E, on land in lease Billings- 28933 analyzed 8,240 B. t. u., air dried, which analysis is indicative of possible higher calorific value for this coal than stated in the published report. The cross sections on plate 1, Bull. 905, however, indicate that all Tongue River coals lie at depths less that 500 feet from the surface with the possible exception of a small area in the southeastern corner of the County, and that between the base of this member and Redwater Creek, all the contained coal beds are likely to be found at depths between 0 and 300 feet from the surface. In consideration of the absence of analyses of each individual bed and the possibility that some of the beds present may exceed a heating value 8,000 B. t. u., air dried, and of the fact that some of these beds are subject to stripping, the Board accepted the minimum classifiable thickness suggested by Collier and Knechtel, namely, 2 feet 6 inches or 30 inches for all coals considered.

<u>T. 19 N., R. 43 E.</u> 1/ Included in outstanding withdrawal Montana No. 1 of July 9, 1910. Examined by Collier, Pierce, and Erdmann in 1927. Their mapping shows the outcrop of beds T and U of the Lebo shale, also bed W of the Tullock in the northern tier of sections and bed S of the Tongue River in the southeastern sections. Beds U and W are reported so impure as to be valueless. Bed T of Bull. 905 (L of the township report) contains enough clean coal at one exposure in the SW$\frac{1}{4}$SE$\frac{1}{4}$ sec. 3, in the aggregate, 3 ft. 2 in., to support a coal classification. Bed S in sec. 25 measured 6 feet. Bed T. attains classifiable thickness to the northeast in the adjoining township on the north but in this township it appears to be decidedly lenticular; consequently, the Board restricted classification based thereon to lands within a one-mile radius of the exposure of the three-foot occurrence in sec. 3. In the southeast part of the township all lands stratigraphically above the crop line of bed S were classified coal.

1/ See figures 6 and 7 in this handbook.

T. 19N. R.43 E., Prin. Mer., MONTANA



After Plate I, Bull.905

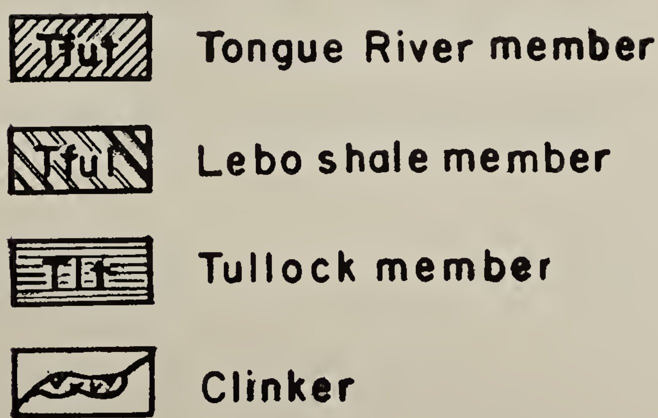
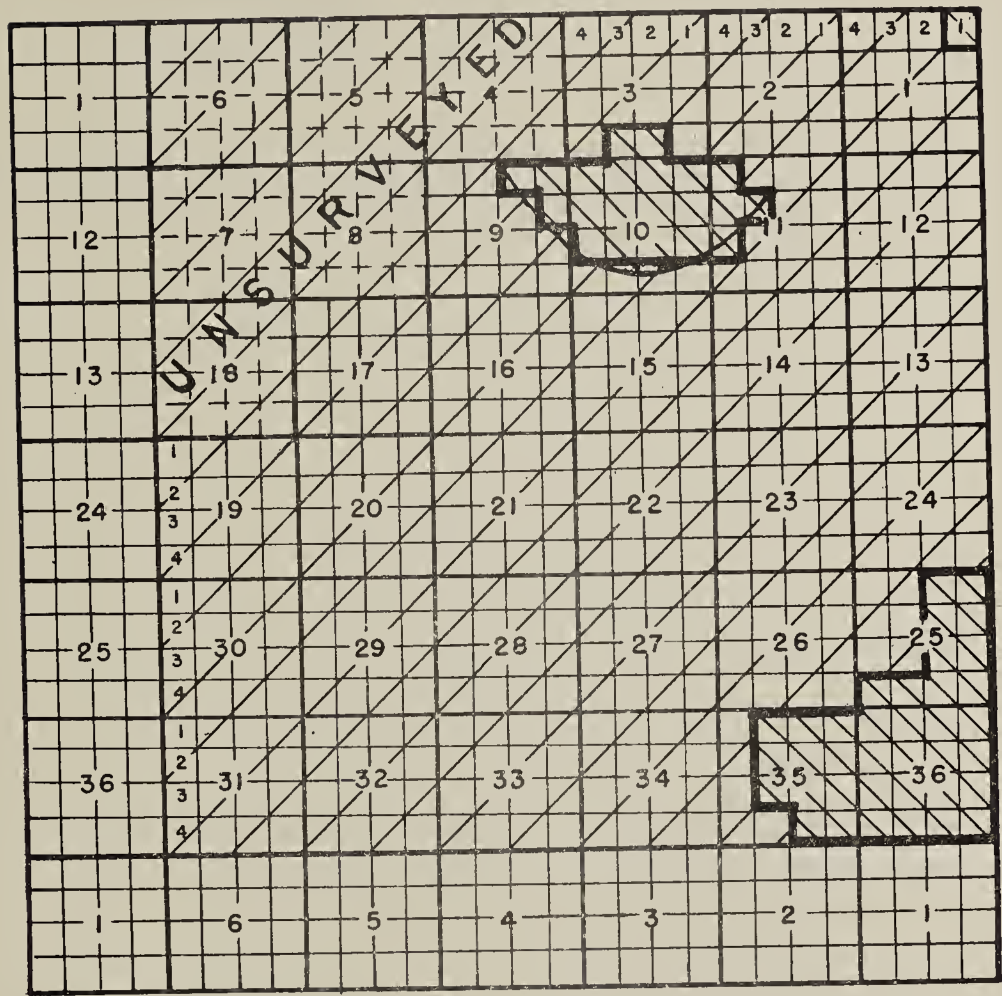


Figure 6

Tp. 19N. *Range* 43E., Mont. *Mer.*

Montana *Land Dist.*



Outstanding withdrawn Mont.#1 7/9/10

Classify coal land and restore

Classify noncoal land and restore

JDN

Ref. Bull. 905 JCM

Coal minutes of Sept. 28, 1940

filed in Gen. Report C-594, (Mont.)

Figure 7

The following subdivisions were classified coal land:

Sec. 1, Lot 1:
3, $SW\frac{1}{4}SE\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$;
9, $N\frac{1}{2}NE\frac{1}{4}$, $SE\frac{1}{4}NE\frac{1}{4}$,
10, $N\frac{1}{2}$, $N\frac{1}{2}S\frac{1}{2}$
11, $W\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $NW\frac{1}{4}SW\frac{1}{4}$;
25, $E\frac{1}{2}$, $S\frac{1}{2}SW\frac{1}{4}$;
35, $E\frac{1}{2}$, $E\frac{1}{2}NW\frac{1}{4}$, $NE\frac{1}{4}SW\frac{1}{4}$;
36, all.

The remainder of the township was classified noncoal. Restoration of the entire township was recommended by the Board....

T. 23 N., R. 45 E. 1/ Included in Restoration No. 82 of April 21 1924. Classified in the northern part as noncoal but the southern two-thirds was classified as coal. Examined by Dobbin et al in 1921. Three outliers of Lebo shale occur across the central portion of the township and another relatively narrow mesa extends from east to west across the southern sections forming a divide between Figure 8 Creek and Flying V Creek. Underlying the Lebo shale, the Tullock member occupies most of the township except the northern sections where the Tullock in turn is underlain by the Hell Creek formation. The dip of the beds is south of east.

Coal beds U of the Lebo, X of the Tullock, and Z of the Hell Creek are present in this township. Bed Z is mapped only in secs. 1 and 7 of this township; bed X extends from sec. 10 to sec. 18; bed U is limited by the Lebo outcrop. The former classification of the major part of this township as coal was based on the assumption that beds X and Z were persistent under cover throughout the township south of the contact of Tullock and Lebo members. The statements concerning these two coals in Bull. 905 and the map in the township record data indicate the variability of beds X and Z and provide little warrant for an assumption that these beds are of classifiable thickness beneath cover everywhere south of the contact. The subdivisions in which outcrops are stratigraphically below bed U were retained as coal lands only within a lens, the diameter of which is determined by points indicated by Dobbin in secs. 10 and 18 beyond which Bed I is consistently less than 30 inches thick. Measurements of bed U ranged from 4 ft. to 10 ft., and the entire unburned area of that bed was retained as coal land.

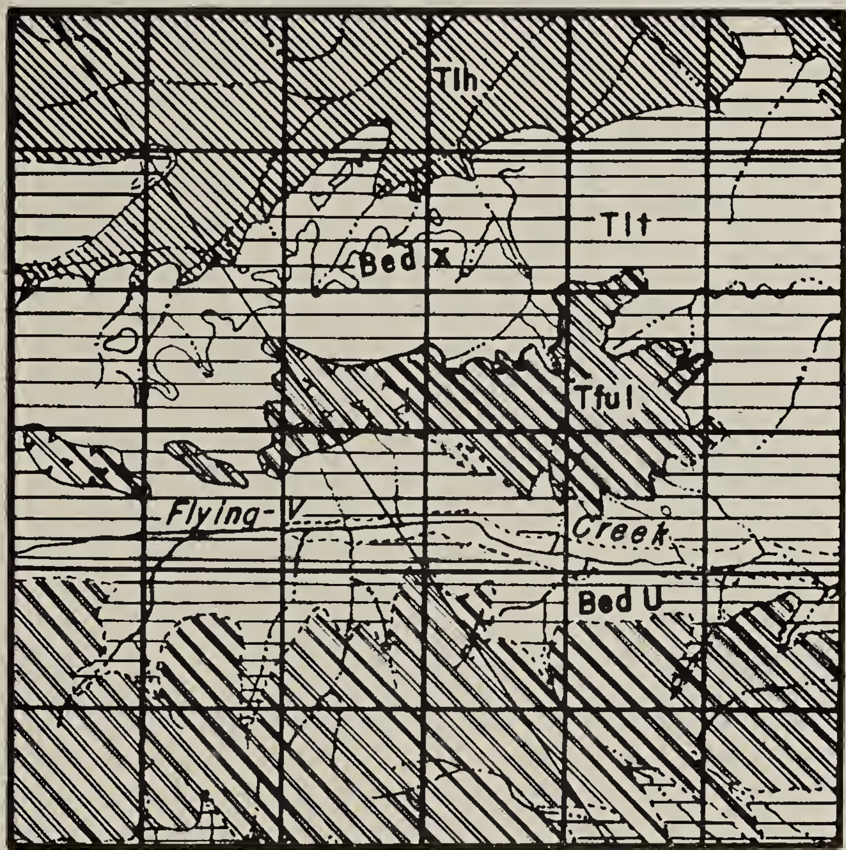
The following subdivisions formerly classified coal were reclassified noncoal by reason of the recognized variability of beds X and Z:

Sec. 8, NE$\frac{1}{4}$NW$\frac{1}{4}$;
10, NE$\frac{1}{4}$NE$\frac{1}{4}$;
11, SE$\frac{1}{4}$NE$\frac{1}{4}$, W$\frac{1}{2}$NW$\frac{1}{4}$, N$\frac{1}{2}$SW$\frac{1}{4}$, NW$\frac{1}{4}$SE$\frac{1}{4}$, E$\frac{1}{2}$SE$\frac{1}{4}$;
12, SW$\frac{1}{4}$NE$\frac{1}{4}$, S$\frac{1}{2}$; etc.

No action is necessary regarding the subdivisions reclassified. The classification of the remainder of the township was not disturbed.

1/ See figures 8 and 9 in this handbook.

T. 23N. R.45E., Prin. Mer., MONTANA



After Plate I, Bull.905

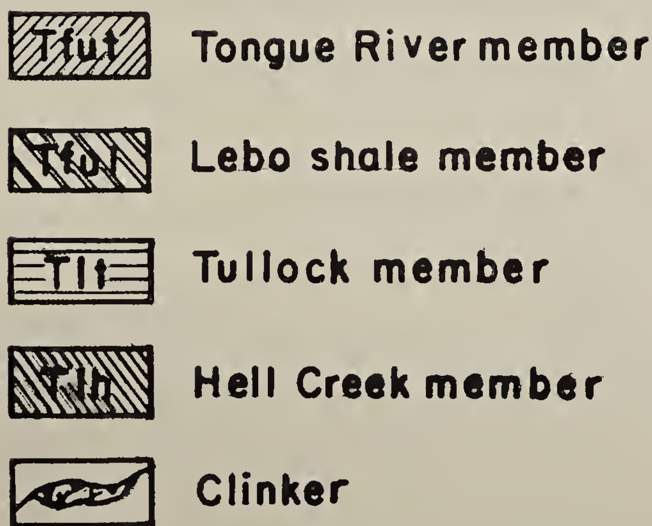
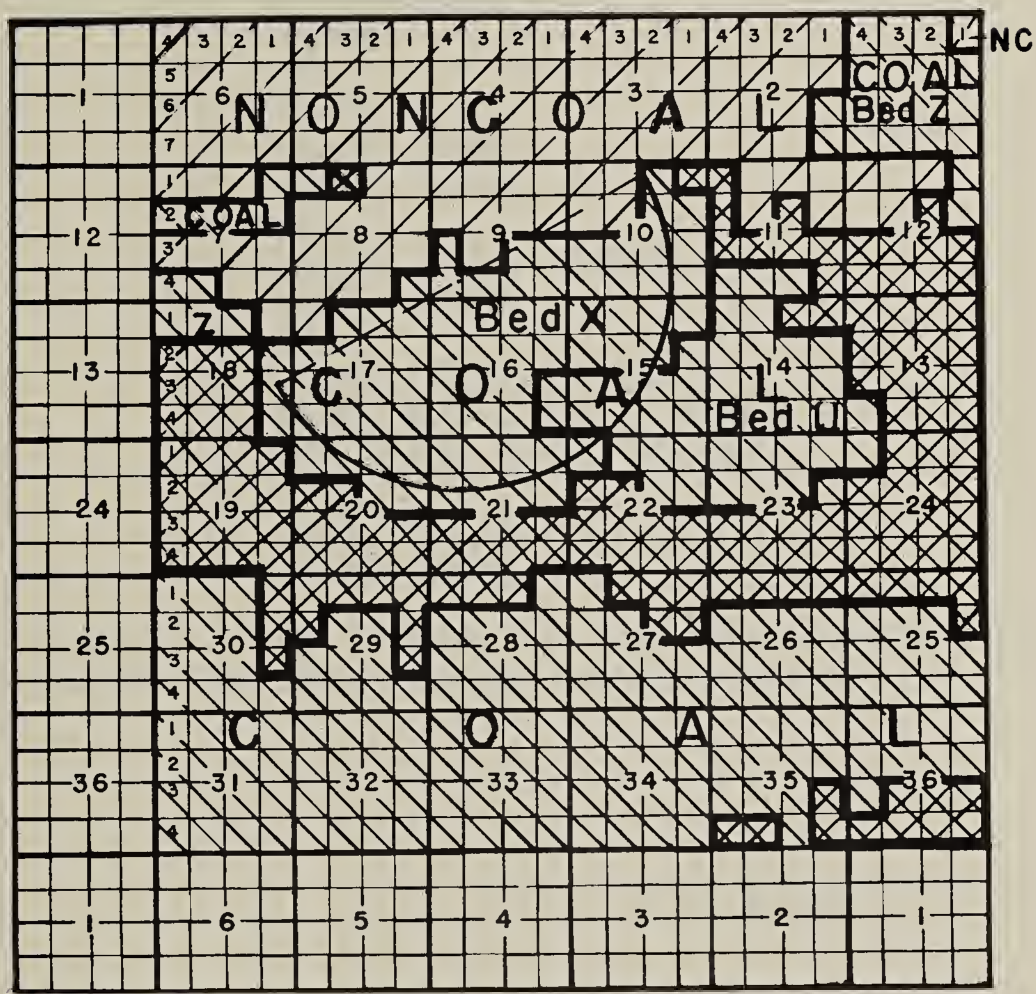


Figure 8

Tp. 23 N. *Range* 45 E., Mont. *Mer.*
Montana *Land Dist.*



Included in Rest. No. 82 of April 21, 1924

Re-classify noncoal formerly coal

No Executive action
JDN

Ref. Bull. 905 JCM

Coal minutes of Sept. 28, 1940 filed in
Mont. Gen. Report C-594

Figure 9

The Board classified the following subdivisions as coal land:

T. 26 N., R. 50 E. (Cont'd)

Sec. 13, $S\frac{1}{2}S\frac{1}{2}$;
14, $NW\frac{1}{4}NW\frac{1}{4}$, $SE\frac{1}{4}SE\frac{1}{4}$;
15, $SW\frac{1}{4}NE\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$, $W\frac{1}{2}NW\frac{1}{4}$, $N\frac{1}{2}SW\frac{1}{4}$, $NW\frac{1}{4}SE\frac{1}{4}$;
16, $W\frac{1}{2}SW\frac{1}{4}$, $SE\frac{1}{4}SW\frac{1}{4}$;
17, $SE\frac{1}{4}SE\frac{1}{4}$;
20, $NE\frac{1}{4}$;
21, $NW\frac{1}{4}NW\frac{1}{4}$;
22, $SW\frac{1}{4}SE\frac{1}{4}$, $E\frac{1}{2}SE\frac{1}{4}$;
23, $NE\frac{1}{4}NE\frac{1}{4}$, $S\frac{1}{2}NE\frac{1}{4}$, $S\frac{1}{2}$;
24, all;
25, $NW\frac{1}{4}NE\frac{1}{4}$, $N\frac{1}{2}NW\frac{1}{4}$, $SE\frac{1}{4}NW\frac{1}{4}$;
26, $N\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}NW\frac{1}{4}$
27, all;
28, $SE\frac{1}{4}NE\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$, $SE\frac{1}{4}SE\frac{1}{4}$;
31, $W\frac{1}{2}SE\frac{1}{4}$, lots 3 and 4, $E\frac{1}{2}SW\frac{1}{4}$;
33, $NE\frac{1}{4}$, $E\frac{1}{2}NW\frac{1}{4}$, $N\frac{1}{2}SE\frac{1}{4}$, $SE\frac{1}{4}SE\frac{1}{4}$;
34, all;
35, $S\frac{1}{2}NE\frac{1}{4}$, $W\frac{1}{2}$, $SE\frac{1}{4}$;
36, $NW\frac{1}{4}NW\frac{1}{4}$, $S\frac{1}{2}NW\frac{1}{4}$, $S\frac{1}{2}$.

The remainder of the township was classified noncoal. The Board recommended restoration of the entire township.

J. C. Miller

J. D. Northrop

Minutes by J. C. Miller

Known Geologic Structure

An outline or definition of a known geologic structure, based on available structure contour maps and other data, is prepared by the Washington office or by the appropriate field office.

Probably no phrase in the Mineral Leasing Act of February 25, 1920 (41 Stat. 437), has resulted in more speculation as to its precise meaning than the phrase "the (or any) known geologic structure of a producing oil or gas field" in secs. 13, 17, and 19 of said law. 1/ Its equivocal variants: "The geologic oil or gas structure of a producing oil or gas field" and "such geologic oil structure" in Sec. 18 of that act; "the geologic structure of the same producing oil or gas field" in Sec. 27; and "the boundary lines of any structure or oil or gas field" in Sec. 32 offer no guidance for administrative action. Neither it nor any variant of it is defined in the leasing act nor to date by the courts, so that legislatively and judicially it appears simply as a scientific and equitable means of distinguishing competitive leasing lands from noncompetitive leasing lands.

The regulations of March 11, 1920 (47 L.D., 437), furnish no specific interpretation of this phrase but merely specify that:

> "the boundaries of the geologic structure of producing oil or gas fields will be determined by the United States Geological Survey, under the supervision of the Secretary of the Interior, and maps and diagrams showing same will be placed on file in local United States land offices."

1/ See Geological Survey Circular 419, "The definition of known geologic structures of producing oil and gas fields," by Emmett A Finley, and Sec. 192.6 Title 43 C.F.R. (Circular 2039).

Administratively the phrase, "known geologic structure of a producing oil or gas field," appears to be neither more nor less than the area defined (published or unpublished) by the Director of the Geological Survey under delegation from the Secretary of the Interior.

Technically, the "known geologic structure of a producing oil or gas field" is the trap, whether structural or stratigraphic, in which an accumulation of oil or gas has taken place. Practically, after many years of administrative action, it may represent a compromise between the technical concept and the practical approach, that is, the official definition includes the acreage reasonably or probably believed to be productive.

It is recognized that the extent and position of any oil or gas accumulation in a "known geologic structure" is influenced to a large extent by reservoir characteristics including factors such as sedimentation, porosity, permeability, and hydraulic pressure. During the development of an oil and gas field, the practice is to include in a definition of the known geologic structure only the acreage that available evidence indicates as probably productive at the time the definition is made. Once the "known geologic structure" of a producing oil and gas field is promulgated, the definition remains in force and effect until it is terminated even after the productive zone is exhausted and incapable of producing in paying quantities.

Lands on known geologic structures, both defined and undefined, are subject to competitive leasing as governed by Sections 17 and 27 of the Act of February 25, 1920.

The date of discovery controls future administrative actions. It is of paramount importance. If by reason of subsequent development it becomes necessary to re-define or modify the existing definition, the date of the completion of the most recently completed productive well is the controlling date for administrative purposes.

The defined structure plats may show either or both of two dates: (1) the effective date, which may be the date of discovery or the date of completion of the most recent well, and (2) the date the Director signed the plat showing the limits of the known geologic structure of a producing oil and gas field.

The first-mentioned date governs the change in rental payments to one dollar per acre for leases within undefined areas and is reported to the Bureau of Land Management by the field accounting offices and by the Survey's "first-discovery" letters. The date mentioned in (2) is the date of formal definition. It specifically registers compliance with Sec. 32 of the leasing law of 1920 which authorizes the Secretary of the Interior "to fix and determine the boundary lines of any structure, or oil or gas field." This authority has been delegated to the Director by the Secretary.

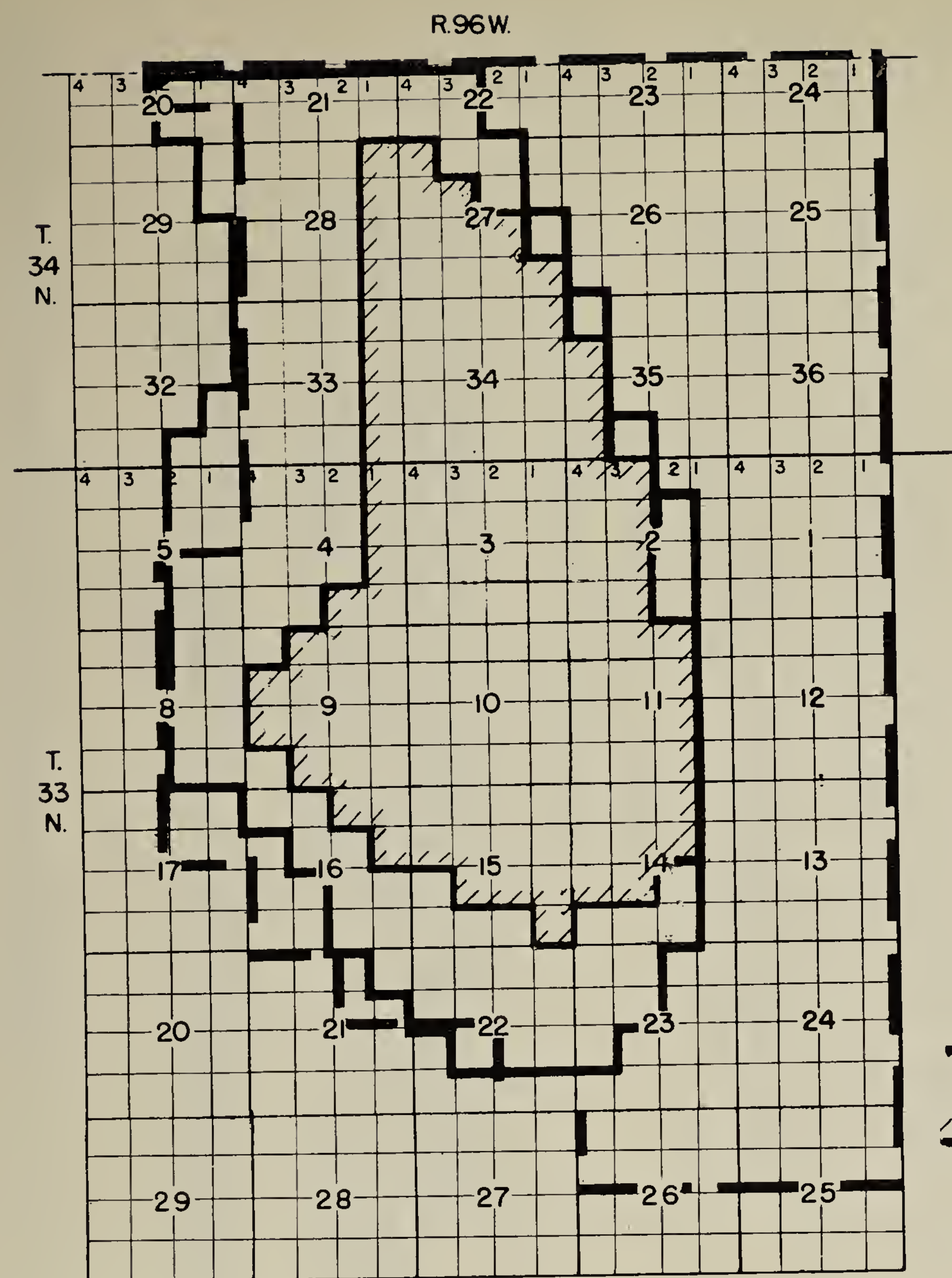
The effective date is the date of ascertainment of fact, the promulgation date is the date the Director has signed the plat. In some cases a considerable lapse of time has occurred between the effective date and the date of the Director's signing; this has been the subject of appeals in recent years.

In the case of plats for other leasable minerals the date used in administrative determinations is the date of promulgation by the Director.

Formal minutes of the proceedings leading to inclusion or classification of the lands within a known geologic structure are prepared, and the plats that show the defined acreage are approved by the Director in advance of publication. Subsequently, the formal plats are processed as described in this chapter under "Preparation, Distribution and Publication of Formal Actions."

Consult the following Departmental decisions for additional information on the effects and purposes of the "known geologic structure:" Vol. 55 I.D., page 530; Vol. 56 I.D., pages 354, 390; Vol. 60 I.D., page 62.

Frequently, known-geologic-structure plats are prepared for lands within an approved producible unit agreement. Special attention should be given to any approved participating area. Defined boundaries may extend beyond the participating area but should never be less than the participating area. See figure 10. General instructions and samples of the Minutes by the Oil Board and township diagrams prepared from such minutes follows:



In accordance with Sec. 192.6, 43 C.F.R. I redefine the known geologic structure of the
BEAVER CREEK FIELD
as indicated hereon, revision effective December 22, 1957

ACTING DIRECTOR
U. S. Geological Survey

September 19, 1958

	Acres
Total previously defined	8,471
Total additional	1,326
Total defined	9,797

Boundary of Unit Area Approved August 6, 1937

Boundary of participating area as of November 28, 1952

Fig. 10 Known Geologic Structure Plat showing unit and participating areas, Beaver Creek Field, Wyo.

Preparation of Minutes of the Oil Board

(Letter-size paper)

File: Name of State ____ O & G Minutes No. [1]

Minutes of the Oil Board
Date

Present: (Geologists preparing data, with petroleum engineers in consultation, if necessary)

Subject: Definition of the known geologic structure of the ______ field, ______ county, (State) .

Par. 1: Date of discovery of oil or gas on structure.
Location of discovery well.
Initial production of discovery well.
Producing formation (name and geologic age).
Depths from which production obtained.

Par. 2. Physiographic and geographic location of structure.
Brief geologic discussion of structure.
Reference to published or unpublished geologic reports which have been considered.
A structure map may be included and made a part of the minutes.

Par. 3: History of development of the field (such as number of producing wells, dry holes, producing formations if more than one, and date of discovery of each).

Par. 4: Based on the above information, the following described lands, embracing ______ acres, are recommended as the known geologic structure of the ______ field, as of __________.

Description of lands

Par. 5: Alternative suggested forms to use:

a: Inasmuch as such definition is based in part on development, it is recommended that the completion date of the most recently completed well affecting this determination be the effective date. Accordingly, November 10, 1957, the completion date of the XYZ Oil Co. No. 6 "Gopher" well, is recommended as the effective date of this action.

b: The date to be considered in any action relating to the land involved in the field is ________, the date that knowledge

1/ Number of the minutes is to be supplied by Washington

of the productivity of the field was first established by the completion of the discovery well.

Geologist 2/

Reviewed: ____________________ (Washington Office)

Geologist 2/

Approved: ____________________

Geologist 2/

Chief, Branch of Mineral Classification

2/ Names to be same as shown after "Present."

Distribution: Original for Washington office; if prepared in the field, the desired number of copies for field offices will be returned; if prepared in Washington, they will be forwarded to the appropriate field offices.

File: Colorado O & G Minutes No. 28
T. 5 N., R. 95 W.

MINUTES OF THE OIL BOARD
May 14, 1957

Present: G. H. Horn, E. E. Richardson (include petroleum engineers in consultation if circumstances warrant).

Subject: Definition of the known geologic structure of the Danforth Hills field, Moffat County, Colorado

The Danforth Hills field was discovered on May 15, 1954, with the completion of the Texas Company No. 1 well in the NE$\frac{1}{4}$SW$\frac{1}{4}$SW$\frac{1}{4}$ sec. 32, T. 5 N., R. 95 W., Sixth Principal Meridian, Colorado. This well was completed with an initial production of 323 barrels of 32.2^{o} gravity oil per day from the Jurassic Morrison formation between the depths of 6552 to 6558 feet and 6625 to 6647 feet.

This field is in the northeastern part of the Piceance Creek Basin on a small local structural high on the Danforth Hills anticline. This field has a structural closure of about 75 feet. Oil accumulation is controlled by structure and lenticular sand development. Exposed rocks are the Iles formation of upper Cretaceous age. Reference is made to "Geologic and Structure Map of the Maudlin Gulch, Temple Canyon, and Danforth Hills oil fields and Vicinity, Moffat County, Colorado," which was used as the basis of this definition.

In the development of this field three oil wells have been completed and two dry holes drilled. A discovery of oil in the Jurassic Entrada sandstone was made on August 27, 1955, on the completion of the Texas Company No. 2 well in sec. 32, T. 5 N., R. 95 W., for an initial production of 157 barrels of oil per day. Presently, two wells are producing from the Morrison formation and one from the Entrada sandstone.

Based on the above information, the following described lands, embracing 480 acres, are recommended as the known geologic structure of the Danforth Hills field:

Sixth Principal Meridian, Colorado

T. 5 N., R. 95 W.,

Sec. 31, $E\frac{1}{2}NE\frac{1}{4}$, $NE\frac{1}{4}SE\frac{1}{4}$

Sec. 32, $NW\frac{1}{4}NW\frac{1}{4}$, $S\frac{1}{2}NW\frac{1}{4}$, $SW\frac{1}{4}$, $W\frac{1}{2}SE\frac{1}{4}$

Inasmuch as such definition is based in part on development, it is recommended that the completion date of the most recently completed well affecting this determination be the effective date. Accordingly, October 12, 1956, the completion date of the Texas Company No. 3 well is recommended as the effective date of this action.

G. H. Horn, Regional Geologist

Reviewed: ____________________

E. E. Richardson, Geologist

Approved: ____________________

Chief, Branch of Mineral Classification

Preparation, Distribution, and Publication of Formal Actions

The final papers required in classification actions and the preparation and handling of the papers are described in the following paragraphs:

1. Preparation of Formal Classification plats (figures 10, 11, 12, 13)

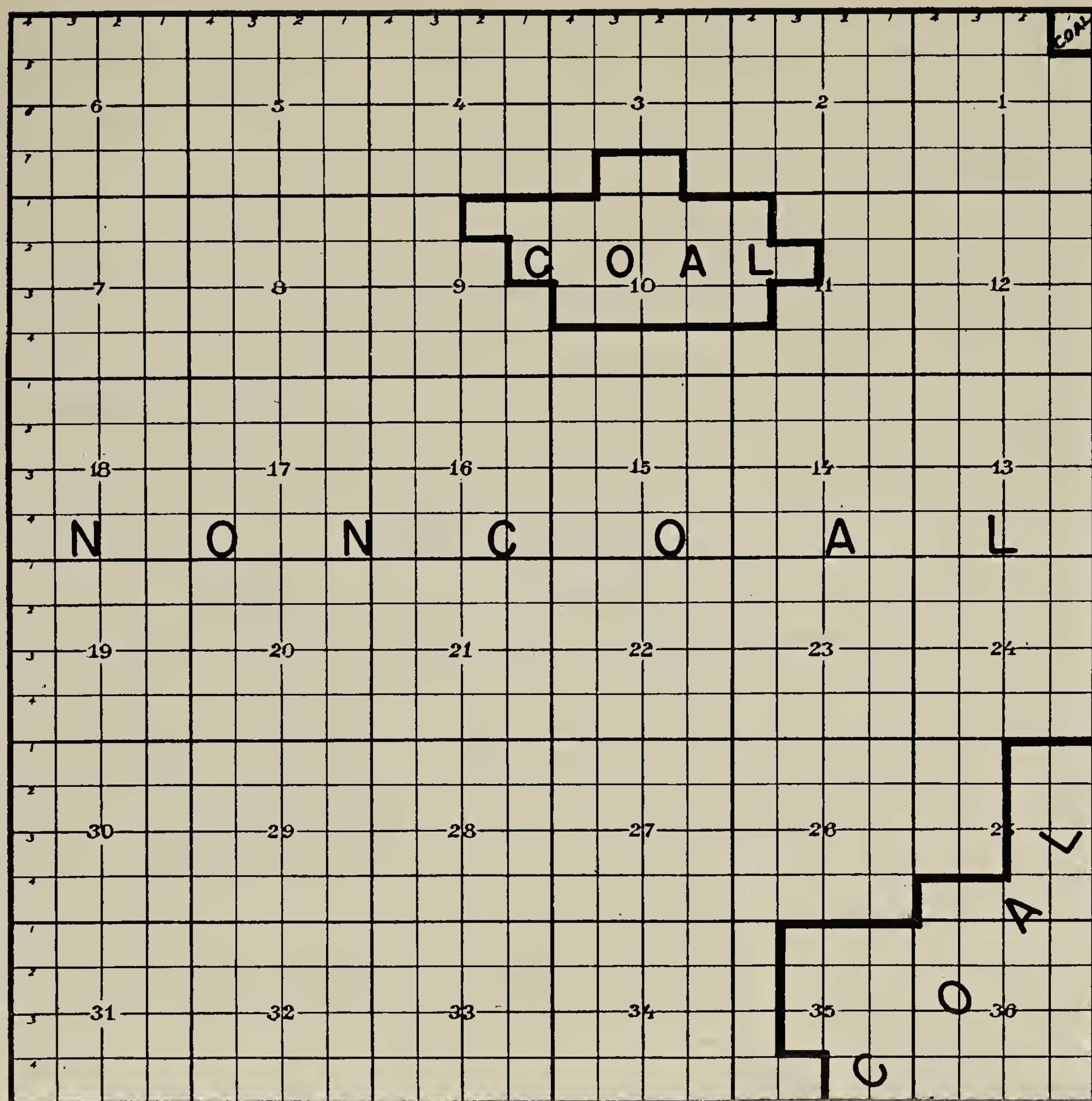
Coal and other solid leasable minerals. -- After a set of minutes have been approved by a board, plats showing the formal classification as determined by the geologist are prepared for the approval of the Director. These are drawn up in the Branch usually on a scale of one inch to the mile, except in the case of a very large area, and show all lots and tracts within the township. Figures 11 and 12 are copies of township plats showing coal and noncoal classifications. The total amount of acreage classified or reclassified as mineral or nonmineral and the total acreage in the township are shown. Branch copies show a restoration number with the recommended and promulgated (approved) dates, the date of the board action, and any revision in acres reclassified mineral or nonmineral, and the Branch file in which the minutes of the board are filed.

Oil and gas (known geologic structures). -- Figures 10 and 13 are samples of defined structure plats. Where the known geologic structure of a producing oil or gas field covers acreage in two or more townships, the area should be included on a single sheet rather than separate township plats. Copies may be filed in two township files. This practice has also been followed in the outlining of a known sodium area near Green River, Wyoming, the

Township 19N. *Range* 43E., *of the* MONT. *P.M.* MONTANA

Restoration No. 92
Recommended Jan. 3, 1941
Approved Jan. 14, 1941
Board action Sept. 28, 1939
Minutes filed G. R. C-594

Revision
Noncoal
Coal
Total



	New	Old outstanding
Noncoal	20,021	
Coal	2,360	
Total class'n.	22,381	
Withdrawn pending class'n.		
Not withdrawn Not classified		
Restored without class'n.		
Total Township	22, 381	

I classify the land in this township as shown hereon.

DIRECTOR.

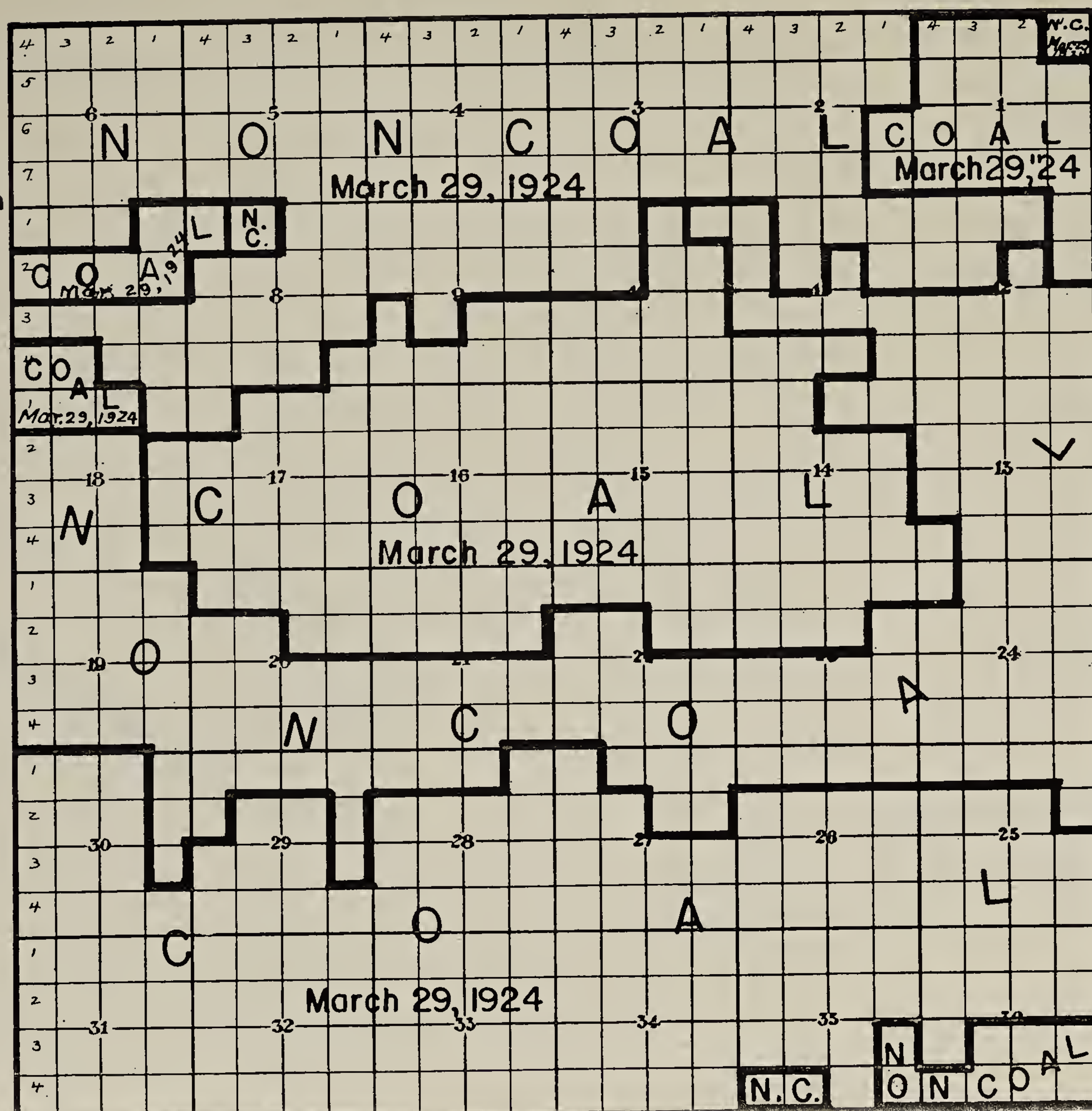
U.S. Geological Survey

November 23, 1940

Figure 11

Township 23N. Range 45E., of the MONT. P.M. MONTANA

Restoration No. ✓
Recommended ✓
Approved ✓
Board action Sept. 28, 1939
Minutes filed G.R. C–594
Revision Reclassification
Noncoal 6,003
Coal
Total 6,003



	New	Old outstanding
Noncoal	6,003	5,016
Coal		11,905
Total class'n.	6,003	16,921
Withdrawn pending class'n.		
Not withdrawn Not classified		
Restored without class'n.		
Total Township	22,924	

131

I classify the land in this township as shown hereon.

W C Mendenhall

DIRECTOR.

U.S. Geological Survey

November 23, 1940

Figure 12

TORCHLIGHT FIELD

T. 51 N. Rs. 92-93 W., 6th P.M., WYOMING

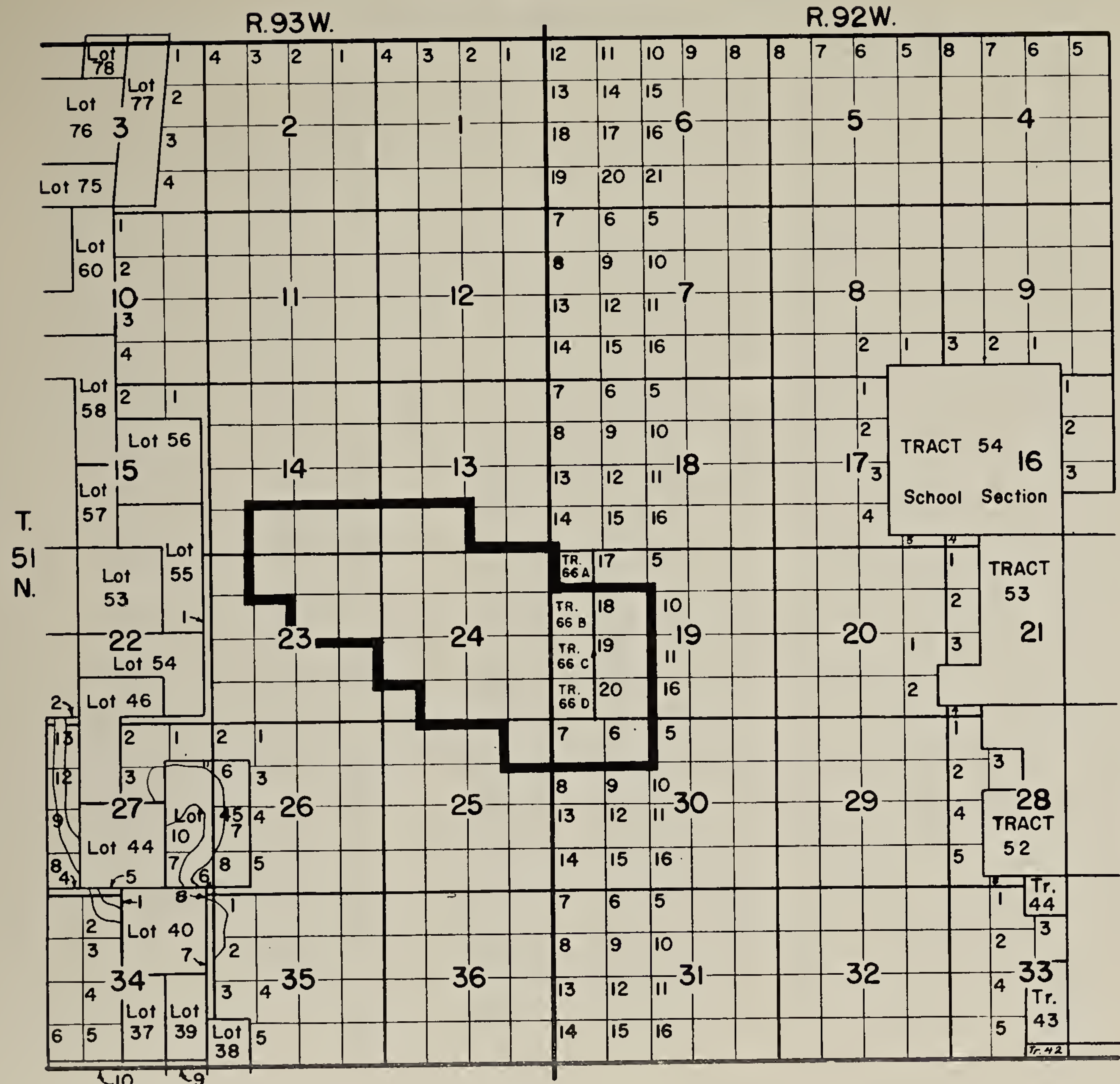


Figure 13

In accordance with Sec. 192.6, 43, C. F. R. I redefine the known geologic structure of the TORCHLIGHT FIELD as indicated hereon, revision effective August 1, 1955

Arthur A. Baker

ACTING DIRECTOR

U. S. Geological Survey

December 31, 1956

	Acres
Total previously defined	1,004
Total additional	400
Total defined	1,404

potash areas in Utah and New Mexico, and the sodium-potash area at Searles Lake, California. In the case of other leasable minerals, it is customary to prepare a plat for each township.

2. Preparation of Formal Classification Orders (See Form Book prepared by the Branch).

To effectuate and complete the classification actions taken by the various boards, orders will be prepared for the signature of the Director, Geological Survey. For determinations or revisions of a known geologic structure, necessary statements will be included on the classification plat showing the area involved. For the other leasable minerals, however, a classification order, in addition to the plat, will be published in the Federal Register. The principal difference between oil and gas and other mineral classifications is the more transitory nature of a know-geologic-structure determination, which may be revised many times by reason of subsequent development. Also, new known-geologic-structure determinations are simply announced by publication of their names in the Federal Register without detailed description of the lands involved. For the solid leasable minerals, a classification may stand indefinitely; the land descriptions can therefore be published with less likelihood of change.

Classification orders for the solid leasable minerals will show:

1. The authority or authorities under which the order is being issued.
2. The purpose of the order and the action taken.
3. The legal description of the land involved.
4. The date signed.

3. Memorandum to Director, Geological Survey, transmitting classification plats for approval (See Form Book prepared by the Branch).

A covering memorandum is addressed to the Director, Geological Survey, from the Chief, Conservation Division, recommending approval of classification. The original township diagrams and orders are attached for signature; until signed by the Director they are not official. One copy of the memorandum when approved is placed in Division files under the mineral involved, and one copy is placed in Branch files under the designated classification order.

4. Distribution of classification plats to the Bureau of Land Management and others (See Form Book prepared by the Branch).

After the original plats have been approved and returned to the Branch they will be reproduced and copies distributed as follows to the Bureau of Land Management and various offices of the Conservation Division:

Coal and other solid leasable mineral plats

No copies of township plats are transmitted to BLM if entire township is noncoal or nonmineral.

3 copies of each plat to the Manager, Land Office, for State involved.

3 copies of each plat to the Director (Minerals Staff Officer) Bureau of Land Management.

1 copy of plat to the Regional Geologist involved.

1 copy of plat to the District Geologist.

1 copy of plat to the Regional Mining Supervisor.

1 copy to the District Mining Supervisor.

2 copies to the Branch of Mineral Classification, Washington office (1 copy, township looseleaf books; 1 copy, township record data file.)

Known geologic structure (producing oil and gas fields) plats

1 copy for each township plus 2 more copies to the Manager of the Land Office for the State involved, except for Colorado for which 2 copies for each township and 1 additional copy goes to the Manager, Denver. (This is a simplification as actually the distribution for each state differs.)

30 copies to Regional Supervisor, Branch of Oil and Gas Operations for State involved.

1 copy of plat to Regional Geologist for the region in which it is located.

1 copy of plat to the District Geologist in that region.

3 copies of each plat to Director (Minerals Staff Officer) Bureau of Land Management, Washington, D. C.

2 copies, Branch of Mineral Classification, Washington office (1 copy, township looseleaf books; 1 copy, township record data file).

When copies of the classification plats are submitted to the Bureau of Land Management on other than known geologic structures, the following data will be supplied for the information of that bureau:

a. List of townships included in outstanding withdrawal showing coal and noncoal classification by legal subdivisions to be included in any restoration order which that bureau may decide to promulgate.

b. List of townships and specific tracts which are reclassified coal land that were previously classified as noncoal on which no formal action is required.

c. List of townships and specific tracts which were previously restored or were not withdrawn but are now classified as coal or noncoal land although no formal action is necessary.

The block in the upper left-hand corner of the township plat is blanked out on the copies transmitted to the Bureau of Land Management inasmuch as this information is for Survey reference only.

Any search of the records of the Bureau of Land Management will be unnecessary by Survey employees with regard to revocation of the withdrawal and to restoration of the lands as these are matters within the jurisdiction of that bureau.

5. Publication in the Federal Register of formal classifications (See Form Book prepared by the Branch).

Pursuant to Chapter I, Title 1, Code of Federal Regulations, a letter will be prepared to the Director, Division of the Federal Register, transmitting either three certified copies of the order listing lands classified as mineral (coal, for example) and/or nonmineral (noncoal, for example), or three certified copies of the notice listing the names of the newly defined known geologic structures. The three copies are certified by a certifying officer of the Survey, who is usually someone on the Director's staff. Copies of the transmittal letter are prepared and distributed as follows: Director's chronological file, 2 copies; Information Office, 1 copy.

An original and 3 carbon copies of the letter and the formal classification list are transmitted to the Federal Register; additional copies of the letter and list are made and distributed as follows:

1 copy of the letter to the Bureau of Land Management.

1 copy of the letter to the appropriate Division file, such as C-10-B

1 certified copy of classification list to the appropriate Division file.

1 copy of the letter to the Branch file, with minutes.

Each retained file copy should show the date of publication in the Federal Register, the volume and page number.

Total originals and carbon copies of letter and list to be prepared: transmittal letter, original and eight carbon copies; classification list, original and three carbon copies, certified.

After each formal restoration action, a record is prepared on a 3" x 5" card for each action on coal and other solid leasable minerals, showing the date of approval by the Director and the total acreage classified mineral or nonmineral. These cards are filed by township and range behind State divider cards. After publication of the classification or restoration in the Federal Register, the numbers and date of the Public Land Order are entered on the record card.

Public Land Orders

Few solid-mineral withdrawals requiring the preparation of Public Land Orders have been made in recent years. Recent Survey policy is to simply report new areas as prospectively valuable until they can be properly investigated and classified. A considerable number of restorations will be required, however, when lands in old outstanding withdrawals are classified. In accord with Departmental Order 2708, dated November 2, 1952, these actions will be handled by the Bureau of Land Management in their serial list of Public Land Orders following recommendations made by the Survey.

". . . The power (of the Executive) to withdraw lands also

carries with it the authority to restore lands. The Act of June 25, 1910 (36 Stat. 847, 43 U.S.C. 141), . . . authorizes the President to make temporary withdrawals, but it also provides that they shall remain in force until revoked by him or by an Act of Congress. Similarly, Executive Order No. 10355 of May 26, 1952, (published in the Federal Register, May 28, 1952) which delegated to the Secretary of the Interior, the authority vested in the President to withdraw or reserve lands of the public domain and other lands owned or controlled by the United States, also delegated the President authority to modify or revoke such withdrawals and reservations 'heretofore or hereafter made.'

"An order vacating a withdrawal does not, in itself, restore the lands. It must state how the lands will be disposed of, or authorize an officer of the Bureau of Land Management to do it by a separate order, before steps can be taken to appropriate or enter them (48 L.D. 507) (51 L.D. 158, 161)." 1/

In connection with the foregoing statements, it should be observed that Executive Order 10355 does not, per se, delegate the authority to the Director, Bureau of Land Management, to modify or revoke withdrawals of such lands heretofore or hereafter made. The Secretary of the Interior is authorized, however, by this order to re-delegate this authority to the Under Secretary and the Assistant Secretaries of the Interior. The "Handbook of Secretarial designations of authority," Chapter 2, Section 1, General Authority, however, indicates that the officers or agencies are delegated the authority they possessed prior to

---

1/ The Fundamental Authorities for Federal Land Ownership and Management (1956), p. 43 and 44.

Reorganization Plan No. 3 of May 24, 1950. The law approved March 3, 1879 (20 Stat. 377, 394), establishing the office of the Director of the Geological Survey provided "that the officer shall have the direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain." Therefore, it is evident that only Congress can change these duties, and these are not affected by the Reorganization Plan No. 3 or by any re-delegation of authority.

Departmental Order No. 2708 of November 7, 1952, delegated the authority to prepare "Public Land Orders" withdrawing or reserving public lands, revoking or modifying orders, withdrawals, reservations, to the Bureau of Land Management.

PART B -- INFORMAL CLASSIFICATION

Introduction

As mentioned in Chapter I, the Branch of Mineral Classification acts in a consulting capacity to other bureaus and agencies besides serving in a similar capacity to the other Branches of the Conservation Division on leasable mineral development and in connection with water resources. Assistance to the other branches ranges from geologic examinations of power sites and lands under lease or permit to special long-term mapping projects, and involves public, acquired, and Indian lands.

Memoranda sent to the Bureau of Land Management on waterpower and reservoir possibilities and mineral value are prepared jointly with the Branch of Waterpower Classification. Special geologic reports are made for the Branch of Waterpower Classification as the result of field

investigations of dam and reservoir sites by the geologists of the Branch of Mineral Classification. Reports are also prepared in collaboration with the Bureau of Mines for the Federal Power Commission on mineral deposits as related to dam and reservoir site applications.

Pursuant to various cooperative agreements of long standing (see "History of Intrabureau Cooperation" in this chapter) between the Bureau of Land Management and the Geological Survey, reports are requested by that bureau on many forms of surface entries, and on mineral leases. These requests consist of (1) the transmittal of serial register sheets pertaining to applications for oil and gas leases and for sodium and potash prospecting permits, on which the reply is stamped and returned to the appropriate land office; (2) the so-called cooperative cases involving reports on various forms of nonmineral entries, which are answered by typed memoranda or by a stamped reply on the Bureau's memorandum; (3) miscellaneous special requests relative to land disposal and management, each of which is necessarily handled by an individual memorandum.

A number of other agencies, both inside and outside the Interior Department, also request reports on the mineral value of certain tracts of land under their respective jurisdiction. These agencies include the Bureau of Reclamation, Bureau of Indian Affairs, Federal Power Commission, Department of Defense, Department of Health, Education and Welfare, and the Department of Justice, among others. Memorandum mineral reports are submitted to the respective agencies in each instance.

A "Form Book" has been compiled for use in the Washington office or in the field offices in which book various typed, printed, and stamped

reports to other bureaus are shown. These reports constitute informal classification of the land involved inasmuch as they are based on a review of available maps and data and usually require no field work by Survey employees.

Several samples of form letters and memoranda are also included in the book that illustrate procedures for making known to the public through the Federal Register or the Bureau of Land Management formal classification of lands for mineral leasing purposes and for restoration or revocation of any outstanding withdrawals or reserves.

Intradivision Cooperation

Branch of Oil and Gas Operations

First Discoveries

One of the duties of the Mineral Classification geologist is to report the lands deemed to be affected by a discovery of hydrocarbons on Government lands or on patented lands affecting Government lands. Authority for this action is contained in 43 C.F.R. 192.6.

The current procedure is for the District Engineer, Branch of Oil and Gas Operations, to furnish the appropriate Regional or District Geologist a copy of his memorandum reporting the discovery. On receipt of this copy, the geologist is expected to prepare his recommendation and to transmit such report to Washington, together with one copy of the discovery memorandum.

Primarily, the report of the geologist should describe, by legal subdivisions, the lands that he believes to be the known geologic structure affected by the discovery; whenever necessary, a brief

supporting statement should be included as to geologic factors influencing his determination. The factual data regarding the discovery contained in the engineer's memorandum should not be repeated. Supplemental data may be submitted but should be identified as such. Any disagreement between the two offices relative to well data should be resolved prior to transmittal of the report to Washington.

It is not anticipated that field examinations will be necessary in order to prepare the required report. The report should be brief; whenever possible, it is desired that the geologist place his comments directly on the copy of the engineer's memorandum. If warranted, a sketch map of the structure may be included in the report.

One of the main purposes of the aforesaid letter reports is to provide background data on which to classify lands as being within a known geologic structure. The determination is then reported to the Land Office in order that rentals may be considered in connection with the new classification. It is, therefore, urgent that the field reports be transmitted to Washington as early as possible.

Unit and Participating Areas

Mineral Classification geologists in the field lend further assistance to the Branch of Oil and Gas Operations by giving geological advice in the reviewing of proposed unit areas and in the establishment of participating areas. The geologist will also consider enlargements or reductions of unit and participating areas and make appropriate reports and recommendations to the Washington office and to the Regional Supervisor of the Branch of Oil and Gas Operations.

The objective in reviewing a proposed unit area is to ascertain

if the area selected, based on available knowledge of the structure and stratigraphy, represents a logical unit area geologically. The review is also based on published material and the geologic report submitted by the applicant in support of the area selected. Points that the review should consider are: whether the proposed area involves more acreage than warranted by geologic evidence, or whether all acreage has been included that is within the limits of the structural or stratigraphic trap, and whether the proposed drilling depth of the test well will penetrate and test all favorable formations.

When reviewing proposed participating areas or revisions thereof, the geologist should determine whether all lands reasonably proved productive in paying quantities, as required by the unit contract, have been included. This review should be based on geological or other pertinent data resulting from development in the area.

Surface Investigations

On request of the Oil and Gas or Mining Supervisor, surface investigations by the Mineral Classification geological staff are to be conducted when data are desired on certain areas under development. Such investigations are to be planned in advance and fitted into the work schedule with reasonable dispatch. If approval of the job or investigation by the Branch Chief is warranted a description of the job should be submitted to Washington before it is commenced. Copies of all reports and maps prepared as a result of such investigations are to be furnished the Supervisor and the Washington office. These reports, in keeping with Survey policy, should be identified as "For Administrative Use" until the report or map is published or otherwise

made available to the public. (See Chapter VI for relative weight in Monthly Report to be given to field reports.)

Spot investigations in the aid of leasing operations are to be made as promptly as circumstances require. Copies of the geologist's report are to be given the Mining or Oil and Gas Supervisor at the time the report is forwarded to Washington.

Subsurface Investigations

Subsurface investigations are to be conducted on areas included in approved units and on other areas where production and development on or near Government land merit such work. The appropriate Supervisor may indicate certain areas where investigations are needed and the geologist may also select areas for investigations in the normal performance of his duties. Results are to be made available to appropriate Division personnel as indicated under Surface Investigations.

Lease Sales

When requests for competitive lease sales of lands included in a known geologic structure are received from the public, from the Oil and Gas Supervisor, or from the Bureau of Land Management, the Branch of Mineral Classification will report to the Branch of Oil and Gas Operations the lands included in the known geologic structure, with the effective date of the definition. The Branch of Oil and Gas Operations then prepares a letter to the Bureau of Land Management recommending the sale of the vacant lands included therein.

Branch of Mining Operations

(Contributed by the Branch of Mining Operations)

Field Investigations of Mines and Prospects

Inactive areas (not under mineral permit or lease) -- In inactive areas where land is withdrawn for classification, or where reclassification is desirable owing to revised standards, progress in the work of classification is of interest to the Branch of Mining Operations; this view applies particularly to those areas in the Western States where continued industrial growth suggests that mineral leasing will be on the increase in comming years. Land so classified will not necessarily be "workable" or "valuable" under present economic and technologic conditions, although it will be prospectively workable or valuable.

Applications -- Unlike applications filed with BLM for oil and gas leases, which are reported on directly by Branch of Mineral Classification and do not require action by the Branch of Oil and Gas Operations, applications for permits or leases for coal, potash, and other leasable minerals are submitted by BLM to the Regional Mining Supervisor rather than to the Regional Geologist. The report on which BLM will act takes into consideration not only geologic factors but also engineering and economic factors. For coal, the question of "workability" is in the law, as are the phrases "commercial quantities" and "most economical mining." For most other minerals, the laws speak of "valuable deposits," but under the leasing regulations this appears to be essentially synonymous with "workable" or "commercial." Permits for potash, sodium, and acquired-land minerals issue with reference to the term "workability," the lease issuing upon discovery of a "valuable deposit." Noncompetitive phosphate leases issue when "further prospecting is necessary before development can

reasonably be undertaken."

With workability the deciding factor in the question of competitive vs. noncompetitive leases, the relative weight to be given geologic, technical, and economic factors will be different for each application. Where geologic factors have a significant bearing on the decision, the Regional Mining Supervisor will normally call upon the Regional Geologist for a report. On receipt of this report, he will take its conclusions, as well as technologic and economic factors, into account in drafting the Survey report to the BLM on the application.

The report of the Regional Geologist, in order to be of most use to the Regional Mining Supervisor, should:

1. Be timely.
2. Be based upon field observation.
3. Be brief.
4. Be illustrated with necessary maps, sketches, cross sections, and columnar sections.
5. Cover adequately those geologic factors pertinent to the question of workability.
6. Cover the question of "logical leasing unit" from the standpoint of the mineral classification of each 40-acre area covered by the application.
7. Give the source and date of those geologic data having the greatest bearing on the recommendations of the Regional Geologist.

<u>Aid to Permittees and Lessees</u>

The Act of March 3, 1879, establishing the Geological Survey provides that members "shall execute no surveys or examinations for private parties or corporations." The Mineral Leasing Act of 1920 and related laws, however, authorize the Secretary to exercise various

specified discretions "if the public interest will be subserved thereby." Within this framework, the Regional Geologist may furnish requested geologic advice to lessees and permittees through the Regional Mining Supervisor concerning lands under their own lease or permit, or concerning published information on other areas; the request may originate with the Regional Mining Supervisor or with the lessee or permittee.

Discoveries

When a permittee applies for a noncompetitive lease on the basis of discoveries made in prospecting and a geologic problem is involved, the Regional Mining Supervisor may ask the Regional Geologist for a report. He may also request reviews of geologic reports submitted by an applicant.

Branch of Waterpower Classification

(Contributed by the Branch of Waterpower Classification)

Field Investigations of Dam and Reservoir Sites

Geologic examinations of waterpower sites are made at the request of the Branch of Waterpower Classification. The term, waterpower site, refers to the several features required for a prospective waterpower development and includes dam sites, spillway sites, reservoir sites, tunnel or canal routes, and powerhouse locations. In general, field examinations will be confined entirely to surface observations. Occasionally these may be supplemented by seismic or resistivity determinations if the sites are of especial importance or at strategic locations. The reports on the examinations are to be prepared for publication, either as individual reports or as sections or chapters of

water utilization reports. Assuming continuance of current practice, the reports will be published as water-supply papers.

The sites or features to be investigated are specified by the Branch of Waterpower Classification, based on probable schemes of development indicated by topographic conditions. Generally the investigations follow a stream survey. Maps of the stream valley, on a scale of 1:31,680 or 1:24,000, are usually available, along with detailed maps of prospective dam sites on a scale of 1:4,800 or 1:9,600.

Practically all waterpower developments require a certain amount of storage or reservoir capacity, to equalize the streamflow to permit continuous operation. The dam is the key structure in most developments, and the investigation of the dam site will receive the major consideration in the study of a waterpower site. As previously indicated, the investigation is generally based on surface observations. Before final plans are made for any development by Government or private industry, the site must be explored by drilling, test pits, or similar means, all measures beyond the scope of the Geological Survey.

The geologic investigations will bring out the features and conditions that can be determined from surface observations. On the basis of these observations, some conjectures on probable subsurface conditions can be made, and a program for the more thorough and complete investigation by drilling can be outlined. Results of surface observations alone can rarely determine the geologic feasibility of a dam site. The investigation is intended rather to describe the

geologic conditions at a site, how these would affect any contemplated development, and to point out the problems that would have to be solved by the designing and construction engineers prior to actual development.

The primary purpose of the geologic investigation of a reservoir site is to determine whether or not there might be any serious leakage due to permeable material, faults, or fractures. Another factor to be considered that might not affect geologic feasibility but would have a definite bearing on economic feasibility would be the presence of valuable mineral deposits in or adjacent to the reservoir site. In cases where development is imminent, consideration should be given to geologic mapping of the reservoir site in order to record the mineral information while it is still possible to do so even though such information is not needed for the immediate purpose of classification studies.

In considering the geologic feasibility of a prospective waterpower site, and to fully understand and properly appraise the geologic conditions, the studies must frequently be extended considerable distances beyond the area that will be included in any probable development.

The content and arrangement of the report will depend on whether it will be published as an individual report or combined with the water utilization report prepared by the Branch of Waterpower Classification. In the latter case certain items of general information can be omitted as these will be covered in the section on water utilization. Various outlines have been proposed for geologic reports relating to waterpower sites. It is not considered practicable to specify a

definite outline or table of contents as each report must be considered individually.

Reference to the following published reports will serve as a guide to an author in organizing a report:

> USGS Water Supply Paper 866 (parts a, b, and c), 1941, 1944, 1947.
>
> USGS Circular 136, 1951.
>
> USGS Bulletin 1031-A, 1955.

W. G. Hoyt, in a "Memorandum re Geologic Work in connection with Power Surveys," dated June 22, 1922, included the following outline or schedule of information that should be collected during the field examinations and discussed in the ensuing report.

> "The primary object of the river and dam-site surveys made at the request of the Land Classification Board is to obtain data needed in the administrative duties of the Board. A considerable portion of the data thus collected is of value to the general engineering public. The engineer making the report will have more confidence in it, and the value of the report is materially enhanced, if the geologic features of the various sites are authoritatively discussed. For these reasons, it seems desirable to have a geologist accompany parties making surveys in regions where complete geologic data are not available.
>
> "In general, the information which should be collected by a geologist may be classed under the following heads:
>
> 1. General geologic information relative to the river covered.
>
> 2. Specific information relative to possible dam sites as located by the hydraulic engineer.
>
>   a. Conditions affecting end anchorages.
>
>   b. Conditions affecting foundations.
>
>   c. Problems of reservoir leakage.
>
>   d. Geology of possible natural spillway sections with reference to stability.

e. Geology of tunnel location with special reference to difficulties to be encountered in construction.

f. Possibility of downstream erosion sufficient to endanger the structure (Gilbert's law).

g. Discussion of additional geologic examination needed to determine proper design and location.

3. Availability of local building materials.

a. Possibility of local manufacturing of cement and availability of concrete aggregate.

b. Availability of suitable local material for earth and rock dams.

"The information relative to the general geology and physiography should be in the form of a report accompanied by a map suitable for presentation in a published report. The information relative to the specific sites should be presented in such a manner that it can be incorporated in the engineer's discussion of the site. Since the published reports will be used largely by engineers, the general discussion and geologic conditions should be presented with as few abstruse geologic terms as possible.

(Sgd.) W. G. H.
Hydraulic Engineer"

Intrabureau Cooperation

History

On June 29, 1906, President Theodore Roosevelt addressed a letter to Secretary of Interior Hitchcock requesting withdrawal from settlement of lands believed to contain minable coal. Following this order the Geological Survey submitted to the General Land Office a list of townships on which "coal is known to occur."

On April 8, 1907, Secretary Garfield approved a proposed scheme for classification and valuation of coal lands on the public domain submitted by Director Walcott.

A "Cooperation Joint Committee" was appointed by the Secretary on November 12, 1908. In these early years much of the cooperation was arranged by verbal agreements between the Land Office and the

Survey, and records of these early proceedings are not available.

The Land Classification Board was organized as a section of the Geologic Branch on December 18, 1908, by order of Director Smith to give geologic advice to the Land Office. The Board consisted of several boards dealing with classification of coal, metalliferous deposits, phosphate, and oil and gas. On May 1, 1912, the Board was given the rank of a branch by Survey Order No. 10.

A cooperative agreement dated July 9, 1910, on coal lands was later extended on January 27, 1911, to include oil, phosphate, and waterpower sites. Cooperative agreements were approved March 5, 1912, to cover cases excepted and not excepted from withdrawals under the Act of June 25, 1910, and on February 12, 1917 the Survey stated that furnishing the General Land Office with nonmineral maps was unpractical and continued to operate under the former agreement. A Departmental order dated March 27, 1911 directed that Indian allotments be referred to the Geological Survey for report on coal, agriculture, and mineral character of the land. Departmental order of January 11, 1912 required that the Geological Survey report on the mineral character, power and reservoir possibilities of all railroad and State indemnity selections in satisfaction of quantity grants, and forest lieu selections under the Act of June 4, 1897, as amended by the Act of June 6, 1900, and selections made by individuals or by the railways under the Act of July 1, 1898. Departmental order of January 18, 1912 provided further, that all selections, applications, or filings not specifically excepted from reservation by and under the Act of June 25, 1910 (36 Stat 847) and under which a vested right was not

secured by the selector, applicant, or claimant should be referred to the Geological Survey for report as directed in the order of January 11, 1912. Under the date of December 20, 1920, the Commissioner of the General Land Office addressed a letter to the Director seeking to modify former cooperative agreements and amendments thereto in order to facilitate action on nonmineral applications. The letter dealt mainly with reports by mineral examiners of the General Land Office transmitted to the Survey for its information after the Survey had reported that it had no specific information on lands not included in withdrawals.

In a letter of December 2, 1919, to the Director, Acting Secretary Vogelsang, proposed a committee consisting of the Director of the Geological Survey, Director of the Bureau of Mines, and the Commissioner of the General Land Office. This committee was requested to report to the Secretary regarding the allocation of the work allotted to each under the then pending Leasing Act.

With the passage of the Leasing Act of February 25, 1920, and the consequent large number of applications for oil and gas prospecting permits, the two bureaus (Geological Survey and the General Land Office), by informal arrangement set up a procedure for handling oil and gas applications. A memorandum to the Director, dated June 29, 1920, from Mendenhall, Chief of the Land Classification Board, indicates that the method of reporting to the Land Office when such applications are within the known geologic structure of a producing oil or gas field, had been worked out in a satisfactory manner.

Land Classification Board Circular No. 52, June 21, 1921,

prepared following a conference with the General Land Office, provided for the type of mineral report to be made on cooperative cases when a critical date is given.

On September 25, 1922, Secretary Fall addressed a memorandum to the Commissioner, General Land Office, the Director, Bureau of Mines, and the Director of the Geological Survey, in which he initiated a program for handling and filing of applications for leases, licenses, and permits under the Acts of February 25, 1920, and of October 2, 1917.

On September 22, 1925, Acting Secretary Finney issued instructions to the General Land Office and the Geological Survey regarding procedure to be followed in handling applications for all leasable minerals and any reports originating from such applications, leases, and permits. As far as can be determined there were no further agreements of this nature between the Land Office and the Geological Survey until May 20, 1942, when Director Mendenhall wrote the Secretary that a report should be obtained from the Geological Survey on applications for lands included in outstanding withdrawlas and on applications for any other lands subject to location, entry, selection, or purchase. On May 21, 1942, the Commissioner, General Land Office, concurred in this recommendation, and on May 27, 1942, Secretary Ickes approved it. This agreement left no doubt that the Geological Survey would be requested to report on all minerals on lands entered for any purpose.

By reason of the decentralization program of the Bureau of Land Management, Assistant Secretary Davidson on August 24, 1948, re-defined the relationships between the Geological Survey and the

Bureau of Land Management. The Secretary ordered among other things that:

> "For all disposal types of cases, such as homesteads, isolated-tract sales, land exchanges, etc., on which a land-classification report as to mineral or power site potentialities are required from the Geological Survey, a carbon copy of the serial register will be sent direct to the Geological Survey, Washington, D. C., from each district land office of the Bureau of Land Management. Report on such cases will be routed direct from the Geological Survey to the district land offices adjudicating such cases . . . .
>
> "Serial register sheets prepared by the managers of the local land offices for noncompetitive oil and gas leases for the States of Washington, Oregon, Idaho, Nevada, and Arizona, and for all of Utah except those areas now defined as within the known geologic structure of a producing oil and gas field shall continue to be forwarded to the Geological Survey at Washington, D. C. The Geological Survey will not, however, report on the applications received from the above states, it being understood that unless and until otherwise informed the managers may issue noncompetitive oil and gas leases without structural clearance from the Geological Survey . . . .
>
> "The managers of land offices will refer noncompetitive lease applications for any land in areas designated by the Geological Survey as within the known geologic structure of a producing oil or gas field to Washington and the report will be made to the Director, Bureau of Land Management . . . ."

On March 31, 1949, the Director, Bureau of Land Management modified these requirements to the extent of including additional states on which no report from the Geological Survey on oil and gas applications would be required. These states were North and South Dakota, Nebraska, and Oklahoma.

In regard to public land entries generally, the Director of the Bureau of Land Management in this memorandum stated:

> "When an application to make entry of public land is filed, the adjudicating office will ask the Geological Survey, Washington, D. C., for a report as to mineral and waterpower resources of the lands.

"Again when the entryman submits notice of intention to make final proof, a re-check should be made to determine whether, in the meantime, the land has become 'known mineral land.'"

By memorandum of December 9, 1952, the Director, Geological Survey, notified the Director, Bureau of Land Management, with reference to his memorandum of March 31, 1949, that conditions make it necessary to modify existing procedures. It was requested that the Salt Lake City land office furnish the Survey with duplicate copies of serial register sheets for non-competitive oil and gas leases, involving lands in the east half of Utah, that is, in (1) the Uinta Meridian and, (2) east of the Salt Lake Meridian. This change was communicated to the Manager of the Salt Lake City land office on February 6, 1953.

On August 11, 1958, the Acting Director, Geological Survey notified the Director, Bureau of Land Management that the Geological Survey now wished to receive the serial register sheets for oil and gas applications in the states of Nebraska and South Dakota. These states were among those for which serial register sheets were not requested, heretofore. The Director, Bureau of Land Management, on September 11, 1958, notified all area administrators and State Supervisors to the effect that serial register sheets for these two states should be added to the list of states receiving them.

As a result of the cooperative agreements cited and in order to expedite replies to requests for reports from the Bureau of Land Management, the Geological Survey has prepared a number of form letters or memoranda which are shown in the Form Book. Some of these replies are in the form of rubber-stamp impressions that are used

directly on the application or on the serial register page to supply the information requested, thereby avoiding a letter reply and some possible errors.

In addition to cooperation with the Bureau of Land Management, the Survey during 1958 agreed to furnish reports to the Bureau of Indian Affairs on the prospective value of Indian lands. This arrangement is indicated in a memorandum from the Director to the Commissioner dated May 2, 1958. Conferences were held later in the year to clarify and to specify the degree of cooperation.

Sec. 402, Reorganization Plan No. 3 of 1946 (60 Stat. 1099), transferred the management of mineral deposits in certain lands from the Department of Agriculture to the Department of the Interior, and Sec. 403 of this same act established the Bureau of Land Management replacing the old General Land Office and the Grazing Service.

Pursuant to the Reorganization Act of 1949, approved June 20, 1949 (63 Stat. 203), Reorganization Plan No. 3 of 1950, effective May 24, 1950 (64 Stat. 1262), provided for the transfer of the functions of all agencies of the Department of the Interior to the Secretary of the Interior. Under authority of Sec. 2 of this plan the Secretary of the Interior, as implemented by Departmental Order 2563, May 2, 1950, re-delegated to the Director, employee, or agency the same functions as they had before.

Bureau of Land Management

"Co-operative" Cases

Requests for reports from the Bureau of Land Management involving applications for the surface use of public lands, are called "co-ops."

As mentioned in preceding paragraphs, their handling has originated as a result of co-operative agreements with the old General Land Office, dating back to July 1, 1910. They often require reports on both the mineral and water resources of specified tracts of land making joint action necessary by the Branches of Waterpower Classification and Mineral Classification. Requests from individual land offices come directly to the Washington office of the Conservation Division, with the exception of Alaska cases which are first referred to the Anchorage office of the Branch of Mineral Classification. Occasionally, direct requests also come from the Bureau of Land Management headquarters office in Washington, D. C. In general, requests from the Bureau of Land Management are the result of individual applications for the surface of specific tracts using any of a multitude of possible types of entry, the more common of which are: homesteads, desert land entries, public sales, state selections, and exchanges.

The Bureau of Land Management on its own initiative has also asked for statewide reports on the mineral value of vacant public lands in connection with land-disposal programs. Requests are usually made by sending in two or more copies of the serial register sheets prepared as a matter of course by the Land Offices, or by means of their special request form 4-110a. The information supplied includes the applicant's name, address, and lands for which application is made, the serial number, date, and type of application. Occasionally requests are received by telegram, teletype, or telephone.

The requests are usually processed through the Branch of Waterpower Classification first, and are then completed and the answer prepared and

signed by the Branch of Mineral Classification. Forms set up to assist in making replies take care of the great majority of cases.

In determination of the mineral character of specified lands, data files are constantly being enlarged and certain procedures followed that insure a reasonably correct answer with as little trouble as possible. Procedures include the use of what are designated as mineral maps, cards, and working plats.

Actual decision as to the mineral character of each tract, once the backgound research is completed, involves consideration of all the pertinent factors. The geologic setting will have been determined, if possible, and any information as to minerals in the area will have been noted. Consideration of each case will also depend to some extent on the kind of minerals that may be involved. For leasable minerals, the Branch of Mineral Classification will usually assume entire responsibility for a determination as to known or prospective value; assistance will be requested from the field offices in this connection when necessary.

For lands in which leasable minerals occur, careful consideration of surface disposal is required to determine if such disposal would unreasonably interfere with leasing operations, now or in the foreseeable future. Concurrence in this determination is secured in every case from the Branch of Mining Operations or the Branch of Oil and Gas Operations.

For minerals on public lands, other than the leasable varieties, positive determinations as to mineral value are seldom made by the Branch of Mineral Classification. When information indicates the possible presence of the locatable minerals the reply ordinarily will

suggest a field examination of the tract in question by the mineral examiners of the Bureau of Land Management. There are several reasons for this procedure: Geologic inference as to the presence or possible presence of minerals of value in the land for disposal purposes takes into consideration economic factors. These can best be determined by the specialist examiners of the Land Offices who carry the designation: Valuation Engineers, Minerals. The classic determination used by the courts should also be considered, that is, minerals must exist in quantity and of quality sufficient to justify a prudent man in the expenditure of labor and means in an effort to develop a paying property. (Castle v. Womble, 19 L.D. 455; Jefferson-Montana Copper Mines Co., 41 L.D. 320) Under this rule certain mineral substances may comprise valuable deposit in some circumstances but not in others. (Opinion, 53 L.D. 294, 296)

The disposition of certain low-value types of minerals, such as ordinary sand and gravel, are handled under the Materials Act (July 31, 1947; 43 C.F.R. 259) and are not considered by the Branch of Mineral Classification as constituting valuable minerals in the sense of the mining laws. Occasionally, however, low-value types, such as building stone, may be mentioned in the reply by the Branch if their development has occurred in the area involved.

Types of replies. -- The mineral resource replies made on public land disposal cases fall into several groupings:

Category 1. Nonmineral.

Category 2. Prospectively valuable for leasable minerals.

Category 3. Valuable for leasable minerals.

Category 4. Possibly valuable for metalliferous and nonleasable nonmetalliferous minerals; in other words, minerals subject to location as mining claims.

Category 5. Miscellaneous replies; such as, color of title, those involving consideration of field examiner's reports, those involving consideration of filing of final proof by entryman, and others of a similar nature.

Category 1. -- Nonmineral. The report by the Branch is notice to a land office, that, on the basis of Survey records, the lands are without value for minerals; the standard for this classification is the "prudent man" consideration, and accordingly, the land requested is "clearlisted." This does not mean that the report may not be changed at some future date, in the light of new information or changed conditions. The land office will be guided by the Survey report but will also take into consideration any other information in its record. For example, unpatented mining claims filed under the Act of May 10, 1872 (17 Stat. 91), and various other acts, may cover the land in question; new mineral discoveries may have been made, such as uranium; a market may have developed for deposits not formerly considered important; or there may be conflicts to adjudicate.

Category 2. -- Prospectively valuable. Completeness of reports in this category as to the presence of leasable minerals, [oil and gas, oil shale, coal, potash (potassium), sodium, phosphate, sulphur (New Mexico and Louisiana only)] are considered a definite function of the Branch of Mineral Classification acting for the Director of the Geological Survey. In other words, reports by the Branch that involve these minerals are considered final by the land offices; they should therefore be prepared most carefully. Favorable areas in which development

has not taken place or on which development has not condemned the land for minerals, are considered of prospective value, and are so reported to the land office. Such reports may be modified as exploration takes place and more data is acquired. At the present time most of these "prospective" reports involve oil and gas based on geologic inference and the sedimentary basin concept.

Lands in leasable mineral withdrawals but not yet formally classified, and lands otherwise considered as having a reasonable prospective value for leasable minerals, will be reported as "prospectively valuable." In the eyes of the land offices both "valuable" and "prospectively valuable" reports have much the same effect, and reservations for the specified minerals would be made in any patents issued.

Category 3. -- Valuable for leasable minerals. In the event of demonstrated value, by actual production, discovery, or adequate mapping, specified lands will be formally classified as mineral land. For oil and gas the formal classification will be in the form of a definition of a "known geologic structure." A discovery will automatically set up an "undefined known geologic structure" until a formal definition is made and signed by the Director. This information action has the same force and effect as the formal definition. (See also Part A of this chapter.) In the instance of requests from the land offices on lands within these areas, the lands will be reported as valuable for mineral. The same is true of lands formally classified for coal land, phosphate, and other leasables.

In connection with leasable minerals, developed or undeveloped, a determination will be made as to whether disposal of the surface would interfere unreasonably with current operations by a lessee or with

operations in the foreseeable future (Act of March 4, 1933, 47 Stat. 1570; 30 U.S.C. 124). If the information available is not sufficient, dependence will be placed on reports supplied by the Branches of Mining Operations and Oil and Gas Operations.

Category 4. -- Possibly valuable for metalliferous minerals and nonleasable nonmetalliferous minerals. Minerals reported under this category would be subject to acquisition and private development under the mining laws. Where the geology and other pertinent factors indicate that the land has possible mineral value, a field examination by the Bureau of Land Management is recommended. The findings by that bureau are generally accepted without further comment inasmuch as it will have taken into consideration laws and economics relative to whether the land is or is not mineral in character.

Category 5. -- Miscellaneous reports. Reports on the less common types of cases are tailored to suit the situation.

Color-of-title cases require only that the Branch report on leasable mineral withdrawals, but some mention may be made of other mineral values. Title will pass to the applicant as to all minerals, unless a withdrawal takes precedence. The reports of the Branch as to mineral value are simply for the information of the Bureau of Land Management.

Burden-of-proof cases involve leasable minerals. These reports are required when the surface entryman has filed satisfactory final proof on his entry. It is necessary first to determine on whom the burden of proof falls in the event a contest is initiated. If, for example, the Survey has reported prior to the date of filing final proof that

the land is prospectively valuable for oil and gas, then the burden of proof is on the entryman to show that this determination is incorrect if he considered that the report should have been a nonmineral report. If the adverse report is later than his final proof filing, then the burden of proof is on the Government. However, if the land was included in a prior classification or withdrawal, such action will take precedence, and the burden of proof will again be on the entryman (see 43 CFR 102.29).

Oil and Gas Reports

Structures. -- The mineral leasing laws prescribe that prior to the issuance of a noncompetitive oil or gas lease, or a five year extension thereof, the Geological Survey will make a determination as to whether the lands applied for are inside or outside a known geologic structure (defined or undefined) of a producing oil and gas field. In addition, the Survey makes further determinations as to what lands applied for are known or believed to be wholly devoid of oil and gas possibilities; are within one mile of the boundary of a Naval Petroleum Reserve or a Helium Reserve; are departmentally exempt from oil and gas filings because lands are dedicated to other uses; and are wholly or partly within an approved unit area. These determinations are usually made by the Washington office of the Branch of Mineral Classification, with assistance of the field offices when requested.

Applications for noncompetitive oil and gas leases are referred to the Geological Survey by the manager of the land office in the form of serial register sheets. If the lands are not within the known geologic structure, they are stamped as shown in Form 1-A in the Form Book.

Applications for extension of time of such leases are also referred to the Geological Survey by the manager. If the lands included in the leases are not within the known geologic structure, the applications are stamped as shown on Form 1-B in the Form Book.

In areas where there is little or no production of oil and gas, the Bureau of Land Management does not request the foregoing reports. The states involved are Washington, Oregon, Idaho, Nevada, Arizona, western Utah, and Alaska. The managers in these states do not refer the applications to the Geological Survey but act upon them in accord with the understanding that the lands are not within a known geologic structure of a producing oil or gas field. As productive areas are developed within any one of these states, this practice will be modified. Rejections of applications in these and other states are not required by the Geological Survey as copies of the original serial register sheets are not filed.

Structure determinations are an integral part of the overall oil and gas work as they are closely related to the reporting of first discoveries affecting Federal lands and the definition of known geologic structures. These actions are coordinated in the Washington office which serves as a clearing house for the pertinent data submitted by the field offices.

Undefined known geologic structure of a producing oil and gas field. -- "Undefined known geologic structure" is a phrase applied to land which by virture of its structural position or proximity to an oil or gas producing well is informally classified as being within a known geologic structure but which has not been included in a formal

definition. It is a "stop-gap" or warning for future final classification. Decisions by the Solicitor, Interior Department, support such determinations and they are considered equal administratively to a defined structure.

Undefined known geologic structures are informally outlined upon recommendations from the field geologist pursuant to IOG-38 reports from the engineers of the Branch of Oil and Gas Operations on first discoveries. The undefined structure is reported to the local office of the Bureau of Land Management (Land Office) by the Washington office of the Branch of Mineral Classification. Undefined structure boundaries are not to be taken as showing the areal extent of the geological structure from which oil and gas is produced. The limit may later be enlarged or reduced to accord with subsequent developments and subsurface interpretations. Inasmuch as undefined structures are not formally platted and published in the Federal Register, greater freedom in acreage selection is permitted as corrections are thereby more readily effected. The area is defined by 40-acre tracts or surveyed lots as in the case of the formally defined structures.

For either known geologic structures or recommendations involving undefined known geologic structures, the field geologist will confer with the Supervisor or District Engineer concerned of the Branch of Oil and Gas Operations. If they are not available, a copy of the proposed action for the undefined known geologic structure should be transmitted to them for their information, at the same time it is sent to the Washington office.

During the early stage of development following a discovery,

known geologic structure determinations help support the Supervisor's demand for a well to protect against drainage of government land.

Productive Limits Determination Under the Act of August 8, 1946. -- One of the functions of the Branch is to make determinations under the Act approved August 8, 1946, 43 CFR 192.82, as to whether lands included in outstanding oil and gas leases were within the productive limits of any oil and gas deposits as of that date.

These requests are initiated by the lessee of record and are answered by the Washington office for signature of the Director, as the authority has been delegated to the Director.

The phrase "known geologic structure" defines boundaries of geologic structures of producing oil and gas fields for administrative use of the Leasing Act and is not a guaranty of production in paying quantities. The phrase "productive limits" necessarily connotes acreage of whose productivity there can be no reasonable doubt. This latter determination is of necessity more exact because the resulting legislative benefits in royalty reduction may be substantial.

Mineral Patents. -- These do not involve the Branch of Waterpower Classification and comprise requests from the Land Offices on applications filed for patents on mining claims made for other than leasable minerals. These requests have come in since the passage of the Multiple Use Act (68 Stat. 708) August 13, 1954, and require a determination as to the presence of leasable minerals. The presence of non-leasable minerals is assumed.

Conflicts. -- Provisions of the public land regulations (sec. 192.71, 43 CFR) provide that when an application for an oil and gas lease is made

for lands embraced in an entry or settlement claim (i.e. homestead), the application will be rejected unless it is found that the land is prospectively valuable for oil and gas. Should the land be found to be prospectively valuable for oil and gas, the entryman or settler will be required to consent to a reservation of the oil and gas to the United States or to contest the mineral finding. Determination of whether the land is prospectively valuable for oil and gas is made by the Branch of Mineral Classification at the request of the Bureau of Land Management.

Administratively, in interpreting this section, the Branch has followed the practice of classifying lands in any geological province with stratigraphic and structural conditions favorable for the accumulation of oil and gas, as prospectively valuable. (See Minutes of the Oil Board, approved by the Director on April 22, 1957, on file in each Branch office.)

Special requests in the case of conflicts not involving the Branch of Waterpower Classification may come to the Branch through the Branch of Mining Operations or the Branch of Oil and Gas Operations or directly from the Bureau of Land Management. In each case, a mineral permit or lease application will be in conflict with a surface entry for the same land. The reply then is simply made as to the prospective nature of the leasable mineral(s) concerned. In other words, if the land is ordinarily reported as prospectively valuable without any conflict then that would still be the report in case of conflict. A little more leniency might be exercised if the nature of the geology indicated only a fair possibility that the minerals

might be present.

Petitions and Appeals. -- Practically all determinations by the Mineral Classification Branch, formal or informal, are subject to appeal. Appeals may follow a petition to modify or alter a determination when a petition is denied. Both petitions and appeals involve leasable minerals almost entirely. The Survey may be called upon to support, geologically, various classifications when a surface entryman contests a mineral reservation. The Survey may also be called upon to support, geologically, findings in connection with known geologic structure definitions, determinations of productive limits, and prospectively valuable determinations.

Appeals are made to the Director, Bureau of Land Management, from decisions of the Manager, Land Office, and to the Secretary of the Interior from decisions of the Director, Bureau of Land Management. The Survey may be requested to enter a case at any stage and support its findings with additional geologic information. Replies by the Branch may sometimes be handled rather informally simply as supplemental reports,but will always be prepared for the signature of the Director of the Geological Survey.

Appeals are usually processed in the Washington office inasmuch as replies are signed by the Director. Field offices may be requested, however, to furnish background information for the preparation of replies to appeals.

Bureau of Indian Affairs

Section 26 of the Act of June 30, 1919 (41 Stat. 3-31), later amended by the Act of March 3, 1921 (41 Stat. 1231), and the Act of

December 16, 1926 (44 Stat. 922), authorized the Secretary of the Interior to lease tribal lands within the States of Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, and Wyoming for the purpose of mining for deposits of gold, silver, copper, and other valuable metalliferous minerals. The Act of March 3, 1921, construed "metalliferous minerals" to include magnesite, gypsum, limestone, and asbestos.

The first general statutory authorization of tribal leasing is found in Section 3 of the Act of February 28, 1891. The 1919 Act in effect extended to Indian reservations in the States named above the procedure of exploration and discovery then in force on the public domain. A second extension of the law authorizing mineral leases on tribal land was effected by the Act of May 29, 1924 (43 Stat. 244), which provided that unallotted land on Indian reservations might be leased for oil and gas mining purposes at public auction by the Secretary of the Interior with the consent of the council speaking for such Indians. The Act of March 3, 1927 (44 Stat. 1347), relating to Executive Order reservations made special provision for oil and gas leases. In order to eliminate any lack of uniformity, comprehensive legislation governing the leasing of unallotted tribal land for mining purposes was enacted on May 11, 1938 (52 Stat. 347). This Act also provided for public auction of oil and gas leases.

Many general statutes are expressly made inapplicable to the Five Civilized Tribes, or the Osages, or to these nations and the Osages, or to all tribes in Oklahoma. Congress passed many special laws for Oklahoma tribes, especially for the Five Civilized Tribes and the

Osages. The Act of May 27, 1908 (35 Stat. 312, 313), provided for leasing of restricted lands for oil, gas, or other mining purposes. The Act of February 14, 1920 (41 Stat. 408), authorized the Superintendent of the Five Civilized Tribes to approve, reject, or disapprove all uncontested leases (except oil and gas leases) subject to right of appeal to the Secretary of the Interior.

The Branch of Oil and Gas Operations makes dollar appraisals for oil and gas on Indian lands. The Branch of Mining Operations makes similar appraisals of Indian lands for mineral value in Oklahoma and other states where such lands are in areas under mining development. The Branch of Mineral Classification when requested, reports whether the Indian lands are or are not prospectively valuable for minerals, metalliferous or nonmetalliferous, including oil and gas, but in no event is a dollar value placed on such tracts.

Bureau of Reclamation

The Bureau of Reclamation occasionally requests reports as to mineral value of lands proposed for public sale within reclamation withdrawals. The request usually asks what reservation should be made to the United States, if any, and if there is any objection to the proposed sale.

National Park Service

The National Park Service requests reports through the Bureau of Land Management on the sale, grant, or lease of public lands for recreational purposes; and on the exchange of public lands to eliminate private holdings from National Parks and National Monuments. These exchanges are effected on the basis of equal value.

The Bureau of Sport Fisheries and Wildlife
of the Fish and Wildlife Service

The Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service has requested reports as to the mineral value of lands involved in a state exchange, as by law such lands are required to be nonmineral in character. Other reports of an informal character have also been made in connection with leasing activities on lands considered to be mineral in character. Reports are also made on the prospective value for leasable minerals in game reserves and refuges or in proposed reserves.

Interagency Cooperation

Requests for assistance from other Government agencies are handled without formal arrangement. Replies are ordinarily made by letter as indicated in figure 5 and the samples in the Form Book. Specifically, reports from the Geological Survey are usually desired as to either, or both, the mineral and water resource value of specified Federal lands or for special determinations required in connection with mineral leases and permits. These requests may involve outright disposal or alienation of the surface estate from the subsurface, the terms of issuance of leases and permits, or may be needed in connection with lawsuits and other conflicts, or exchanges of lands between agencies or individuals wishing to consolidate holdings. Reports involving water resources are handled in conjunction with the Branch of Waterpower Classification of the Conservation Division, whereas those involving only water resources are handled by that branch alone. An example of the latter type of case is a right-of-way application which, because of the automatic reservation of all minerals to the United States, is not deemed to

require a mineral report.

Federal Power Commission

The Federal Power Commission requests reports and recommendations on applications for preliminary permits or licenses for proposed water-power developments from all interested Federal and State agencies. The requests come from the Project Review Coordinator, Office of Assistant Secretary, Water and Power Development, addressed to the Staff Coordinator, Geological Survey. From this office they are routed to various branches in the Survey, including the Branch of Waterpower Classification. The Branch of Waterpower Classification circulates these requests to the Branch of Mineral Classification and to the Geologic, Topographic, and Water Resources Divisions. The Branch of Waterpower Classification prepares the reply for the Geological Survey on the basis of the comments received from the other divisions and the Branch of Mineral Classification. This reply is addressed to the Project Review Coordinator and signed by the Staff Coordinator. The Staff Coordinator also maintains preliminary liaison with the Bureau of Mines. The Project Review Coordinator, in turn, prepares the reply to the Federal Power Commission for the Department of the Interior based on the comments received from the Bureaus within the Department that were requested to report. The Bureaus usually concerned in addition to the Geological Survey are the Bureau of Mines and the Bureau of Reclamation.

The responsibility of the Branch of Mineral Classification in these cases is to assess the extent to which mineral resources will be affected by the proposed projects, and to suggest such further investigations as may be required to provide a satisfactory analysis.

Recommendations regarding the advisability of approving or disapproving the projects will be coordinated with such recommendations from the other Survey Divisions and submitted to the Secretary's office for inclusion in the Department's report to the Federal Power Commission.

Department of Defense

Special geologic reports are occasionally prepared for the Department of the Army, Navy, or Air Force, at their request. These are evaluations of prospective mineral value or for the purpose of ascertaining drainage of oil and gas from lands within specified stations or bases.

Department of Health, Education, and Welfare

The Department of Health, Education, and Welfare intermittently requests reports as to the "known presence of minerals of a commercial nature" and value for lands presently owned by the Government but which have been declared surplus and will be transferred to some local government jurisdiction for educational or similar purposes. Replies are made on much the same basis and reasoning as for "co-ops" but in the event nonleasable minerals might be involved field investigations may be necessary.

Department of Justice

The requests received from the Department of Justice primarily stem from lawsuits in which the United States is involved. They are usually concerned with prospective mineral values or with questions of fact as of a certain date and for specific tracts. In general, it is not the policy of the Geological Survey to tie up its personnel in actual court appearances and only rarely is permission granted by the

Director for this purpose. Instead resort is had to supplying affidavits or other forms of written reports which may be acceptable, depending on the situation.

General Services Administration

The General Services Administration request mineral reports on scattered tracts of Federal lands under its jurisdiction for which it has no further use and disposal is contemplated. Our replies are similar to those prepared for the Department of Health, Education, and Welfare.

CHAPTER VI

CAHPTER VI. -- OTHER PROCEDURES

MONTHLY REPORTS

Monthly reports on the regular program of the Branch are required from each field office and the Washington office. Reports from the field offices serve as a basis for reporting monthly to the Director concerning the progress made on maps and reports being prepared by field geologists. It is therefore important that the percentages of completion shown in the monthly field report be accurate, and that the percentages reflect the changes for each month. The reports are a means of ascertaining the progress toward completion as a result of the geologist's application to the job in hand.

The Washington office prepares a monthly report for inclusion in the Conservation Division report. This Division report consists mainly of statistical data on the administration and disposal of pbulic and acquired lands included in various types of applications.

Those geologists or party chiefs engaged on the long-range mineral classification program will submit to the headquarters office the usual type of progress report each month on the approved form.

At the Denver Conference, July 8-12, 1957, a general discussion was held regarding project nomenclature, the types of investigations conducted by the Branch, and the preferred method of listing in the monthly report. General agreement was reached that the method of reporting work performed should be in accord with the following outline:

A. For approval by Branch Chief:

1. Projects (for publication, if merited by quality of work and area covered. These include mapping projects for which description and justification has been submitted on form 9-1241, revised January 1960.)

2. Investigations (in excess of a week or 10 days and

not originally intended for publication).

(a) Continuing.

(b) Finite.

(c) Administrative.

B. For approval by Regional Geologist:

1. Examinations (not over a week or 10 days):

(a) Spot, field (by request of the Washington office, the Mining or Oil and Gas Supervisors, or other sources).

(b) Miscellaneous:

Proposed unit or participating areas.
Stratigraphic columns, cross-sections, KGS determinations.
BLM requests.
Requests of other branches in the Conservation Division and the Geological Survey.

As indicated in the above outline, approval is required in advance of initiating work.

The following information is required in reporting monthly to the Director concerning the progress made on each project:

1. Date started.

2. Continuing project or not.

3. Current percentage of completion of:

   (a) Field Work
   (b) Office Work
      (1) Map
      (2) Report

4. If no change from previous report, such comment is sufficient.

5. Estimated completion date.

6. Date any report or map is submitted to Washington.

Significant discoveries of any leasable mineral, including oil

and gas, should be reported with appropriate geologic significance and data.

Visitors to the office, official and taxpayers, should be reported. This information may be in the form of a numerical summary, with a short paragraph devoted to each important visitor including a description of the nature of his visit.

Personnel and personal items may be included at the end of the report.

Release of Reports and Speeches

Reports and Maps

Reports on various examinations by the field offices, which reports frequently result from requests by the Supervisors of the leasing branches, are not intended for publication.

Survey policy requires that results of investigations or information to be published must be made available to all the public simultaneously. To conform to this policy, the following rules must be observed:

1. Results of spot examination are to be furnished only to the requesting Branch and the Washington office.

2. Each report and map for Survey files is to be marked "for administrative use."

3. If reports are to be made available to the public without publication, it will be done by placing the report on open file release. A press notice should be prepared by the author and submitted in triplicate to the Washington office with the request for open-file release.

4. When a report or map is to be published by the Survey, a

press notice for the material to be published is to be prepared by the author; for a published report the author also prepares a concise description for insertion in the monthly list of Publication Notices.

Speeches

Speeches, official or nonofficial statements, should be submitttted in duplicate to the Washington office for approval in advance of delivery. Survey Order No. 241 of August 9, 1955, and modifications thereof given in the Survey Manual and material in the Departmental Manual, Chapter 1, Parts 478.1.1, 1.4, 1.5, 2.1, govern the procedure.

Publication

Procedural Agreement

The following agreement between the Conservation Division and the Geologic Division, approved by the Chief Geologist and the Director, is to be used as a guide by all field men; they will be expected to conform rigidly to the procedures established by the agreement:

June 11, 1957

Memorandum

To: Chief Geologist

From: Chief, Conservation Division

Subject: Publication of the Branch of Mineral Classification maps and reports

At the meeting in your office on May 27, 1957 attended by Messrs. Finley and Miller, I understand that tentative agreement was reached on the publication of certain maps and reports prepared by members of the Branch of Mineral Classification.

Normally, the Branch of Mineral Classification geologists cannot devote the time necessary for preparation of bulletins or professional papers; nevertheless, publications

press notice for the material to be published is to be prepared by the author; for a published report the author also prepares a concise description for insertion in the monthly list of Publication Notices.

Speeches and Other Forms of Nonofficial Expression

The Survey's instructions on nonofficial expressions in the form of speeches, lectures, books, drawings or visual methods is covered in the following:

Survey Manual, Part 387.7
Survey Order 241, August 9, 1955
Survey Order 215, February 26, 1952

The dissemination of information gained in one's field of competency while employed outside the Survey does not require advance approval by the Survey. However, there will be instances where additional work on the same study will be encouraged while with the Survey, and leading to publication. This will be true in the case of school theses in particular and the usual official procedures will then be followed.

The dissemination of information on fields foreign to one's employment such as on hobbies, PTA, Boy Scouts, church work, and similar outside endeavors in which one might become involved requires no prior approval by the Survey, unless it interferes with professional work.

Nonofficial expressions that stem from work with the Survey are handled in accordance with Survey Manual, Part 387, unless no publication or remuneration is involved. If the latter is the case approval by the Chief of the Division is all that is required in accordance with the last paragraph of Survey Order 215. Two copies of the paper should be forwarded for approval if policy is involved

or technical review is desired. Form 9-1185 (required by Part 387) has space in item 9 for an abstract, but when the Director's approval is not required and the form is not used either the complete paper or an abstract should be submitted with a letter requesting approval and giving pertinent details.

Publication

Procedural Agreement

The following agreement between the Conservation Division and the Geologic Division, approved by the Chief Geologist and the Director, is to be used as a guide by all field men; they will be expected to conform rigidly to the procedures established by the agreement:

June 11, 1957

Memorandum

To: Chief Geologist

From: Chief, Conservation Division

Subject: Publication of the Branch of Mineral Classification maps and reports

At the meeting in your office on May 27, 1957 attended by Messrs. Finley and Miller, I understand that tentative agreement was reached on the publication of certain maps and reports prepared by members of the Branch of Mineral Classification.

Normally, the Branch of Mineral Classification geologists cannot devote the time necessary for preparation of bulletins or professional papers; nevertheless, publications

should not be barred to them. It should be understood, however, that some of the lands investigated may be in areas where topographic map coverage is inadequate or lacking at the time geologic mapping for classification is required. In that event, mapping will be carried out by plane table or by photogrammetric methods. We hope to proceed with the mapping, classification, and restoration of withdrawn areas more rapidly then we have in the past.

In a discussion of the results of the May 27 conference, it was concluded that prior to embarking on an extensive program of classification of withdrawn lands and the possible publication of the results of mapping, it might be advisable to review the primary objectives and responsibilities of the Mineral Classification Branch. I, therefore, referred to the latest extensive official statement regarding the functions of the Branch and I find there has been no pronouncement since the memorandum for the Director, dated November 2, 1943, by Hale B. Soyster, Chief of the Conservation Division (then Branch). This memorandum, approved by Director Wrather, November 3, 1943, among other things provided for expansion of the Branch and the establishment of regional offices to supply more geologic data and assistance to engineers in the Oil and Gas Leasing, Mining, and Water and Power Branches.

The memorandum of November 2, 1943, further states in part that ". . . in addition to the service function to the other Divisions (now Branches) the geologist will determine geologic feasibility of dam sites, will furnish geologic advice and information to operators on public and Indian lands and to representatives of the Office of Indian Affairs. . ., and will prepare for publication maps and reports describing the results of some of the geological investigations. . . .

"The Mineral Classification Division (now Branch) personnel will make geological surveys and investigations of individual properties, entire fields, and restricted areas and prepare and maintain with frequent revision, in accordance with the results of drilling, structure-contour maps of fields and entire areas, and will in concert with the Oil and Gas Leasing Division (now Branch) engineers, prepare isopach maps, provide interpretations of well logs, well cuttings, cores, etc."

In order that proper preliminary planning may be undertaken for land classification projects, some of which may subsequently be proposed for publication, it is understood that the following conditions shall govern:

1. That the Chief of the Mineral Classification Branch will first submit to the Program Review Board, Geologic Division, project proposals in order to avoid overlapping projects and to

alert other Divisions in the Survey of the work planned. It is assumed that there will be a mutual exchange of information between Divisions concerned with the same area to avoid duplication of effort and conflicting interpretations.

2. That mapping will be planned, as appropriate, on a quadrangle basis as such areas contribute toward the completion of areal geologic maps within the United States and are a more convenient form for eventual publication.

3. That the geologic maps prepared by geologists of the Branch may be published provided they meet Geological Survey standards for the class of publication applicable.

4. That any map or text intended for Survey publication will be given careful technical review and submitted before final drafting to the Staff Geologist for Publications, Geologic Division. He will decide the proper map series or type of publication suitable for the material submitted and forward it to the Geologic Names Committee and the Geologic Map Editors.

5. That the geologists will map areas withdrawn for leasable minerals, including dam sites on public lands, as rapidly as appropriations and personnel permit, and the results will be published, provided these maps conform to Survey standards.

6. That all mapping by the Branch will be directed primarily to investigations of Federal and Indian lands and will be to the scale or size best suited for that purpose.

7. That if and when circumstances justify, a text may be prepared to accompany the map, and both may be published, perhaps in bulletin form, provided they conform to Survey standards for such publication. Under certain conditions text may accompany a map included in a map series.

It is understood that this agreement between the Geologic and Conservations Divisions shall become effective upon approval by the Director.

I concur: /s/ W. H. Bradley 6/20/57
Chief Geologist

/s/ H. J. Duncan

Approved: /s/ Nolan 6/21/57
Director

Conditions for Initial Approval

Prior to a proposed project that involves publication being submitted to Washington for approval, every precaution should be taken to avoid duplication of effort. To this end, a determination should be made as to whether any other member of the Survey is working in the same area, the index of Geologic Division projects should be inspected, and representatives of the Water Resources Division should be consulted.

The procedure outlined in item No. 1 of the foregoing agreement deals with submittal of Mineral Classification projects to the Program Review Board, Geologic Division. This requirement has since been altered by the submittal of form 9-1241 devised and approved June 30, 1959, by the "Inter-Division Committee on Geologic Mapping" in accord with the Director's memorandum of February 24, 1959 to all Division Chiefs on the coordination of geologic mapping activities in the Geological Survey. This Committee revised the project description forms then in use and also proposed a new work plan and accomplishment form. This practice will aid in preventing duplication of mapping as well as assisting in securing information not generally known that may be available in the Geologic Division or other Divisions. Projects submitted by Mineral Classification personnel to the Program Office in the Geologic Division on these forms, now standard throughout the Survey, will be confined to those planned for publication. It should be noted that most routine classification examinations and investigations do not lead to publication. Details of financing are not required by the Program Office. A supply of forms entitled "Program Index, Project Description," will be furnished each field office of the Branch. A

member of the Washington office will be selected to process maps and material for publication; editorial assistance, however, is expected from the Geologic Division.

To obtain Branch and Division approval of a new project, the author should submit to the Chief of the Branch of Mineral Classification, through the Regional Geologist, a memorandum in justification of the proposed work. The memorandum should be accompanied by the aforesaid project description form. If the project is considered pertinent to the work of the Branch and the budget structure permits, approval by the Branch chief will be given.

MINERAL MAPS AND CARDS

A series of state maps showing the location of mines and prospects has been a continuing project of some field offices of the Branch for years because of the accumulation of published material. Minerals leasable under the Act of February 25, 1920, and amendments thereto, including the Act of February 7, 1927, and common varieties of minerals (sand, gravel, and clay) obtainable under the Materials Act of July 31, 1947, should not, however, be shown on such maps. Detailed records of leasable minerals are maintained in the Washington office in connection with formal classification. Information on newly discovered deposits of leasable minerals (including new data on known deposits) should be made the subject of a separate report to Washington. The original idea of the mineral maps, duplicates of which are maintained in the Washington office, was to assist that office in making reports to the Bureau of Land Management, but other agencies often request similar reports relative to minerals on public lands. Such requests, as

indicated in the Work Chart, figure 5, and in Part B, Chapter V, are usually concerned with the mineral possibilities of specific tracts, either owned or acquired by the United States. The intent is to secure information as to whether minerals are or may be present which are either locatable under the mining laws or leasable under the applicable leasing laws.

Card files recording requests by other agencies are maintained in the Docket Room of the Conservation Division and show the land involved and the minerals thought to occur on or near the land. These cards were found to be inadequate, and A. F. Bateman, of the Branch of Mineral Classification, designed a more effective mineral card on which pertinent information relative to mines and prospects is now recorded. The mineral cards have been found useful in the field offices as well as in Washington.

The purpose of the mineral cards, in addition to supporting the mineral maps, is to obviate the need for repeated library research on the same tract by personnel in the Washington office. In developing knowledge of a specific area by such research a reasonable determination of mineral occurrence can be made and reports prepared accordingly. The cards are 4" x 6", one copy being filed in Washington and a duplicate in the field office. A sample card in enclosed in the pocket at the back of this handbook. The card is set up to emphasize specific location as well as the mineral(s) involved. The rest of the information is supplementary and used principally to develop an idea as to the mineral possibilities of the deposit and to supply the best references for further investigation if necessary. On the back of the card is a

plat and space that may be used for additional information as befits the situation, for example, one card might suffice to report on gypsum for an entire township by the placing of a township sketch on the back.

The mineral maps should show location as accurately as possible, commensurate with scale. For particularly active mining districts it is sometimes sufficient, however, to outline a general area instead of showing a multiplicity of points, the details being established largely by the cards. So long as the maps are used only for administrative purposes, area deposits such as gypsum, heavy mineral placers, and uranium can be included without confusing the picture too much.

The first state maps in the survey showing the location of mines and prospects were prepared in the Branch in 1947 and covered the states of California, Nevada, and Oregon. They established the use of specific symbols for particular mineral occurrences, whether mines or prospects. A uniform scale of 1:500,000 has also been established for the maps.

CHAPTER VII

CHAPTER VII. -- CLASSIFICATION STANDARDS

INTRODUCTION

Classification standards have been prepared recently for coal, oil and gas, potassium, oil shale, sodium, and phosphate. These represent changes in specifications for determining whether these leasable minerals occurring in the land meet certain minimum classifiable limits. The old standards or regulations, as they were known, for coal and phosphate are given in Bulletin 537, pp. 65-70 and pp. 123-133.

Classification of oil and gas lands was based on the anticlinal theory almost entirely, but in addition to structure, the Board considered stratigraphy, the continuity and character of the oil sands, the quality of the oil, the presence or absence of water, the depth, thickness, and porosity of the reservoir rock.

Potash and related salines were given slight mention on pages 134 to 137 of Bulletin 537, but at the time of publication (1913) there were no known potash deposits in the United States of commercial value. The authors, however, took cognizance of the known deposits of sodium chloride and of the saline lakes and playas of the West.

The new standards that follow have been taken from the Minutes of the Classification Boards, representing in most particulars a revision of the old standards for the purpose of recognizing improvements in techniques during the past 40 years. Graphs have been prepared to show the parameters prescribed by these classification standards.

CLASSIFICATION OF COAL LANDS (REVISION)

Conditions Necessary for Classification of Land as Coal Land

Land shall be classified as coal land if it contains coal under the following general conditions (see figure 14):

(a) Thickness -- 14 inches or more.

(b) Quality -- 6000 Btu per pound or greater (air-dried, washed or unwashed, unweathered).

(c) Depth -- less than 5,000 feet.

(d) Any isolated tract or legal subdivision underlain by more than 2,000 tons of coal of classifiable quality and thickness exposed at the surface.

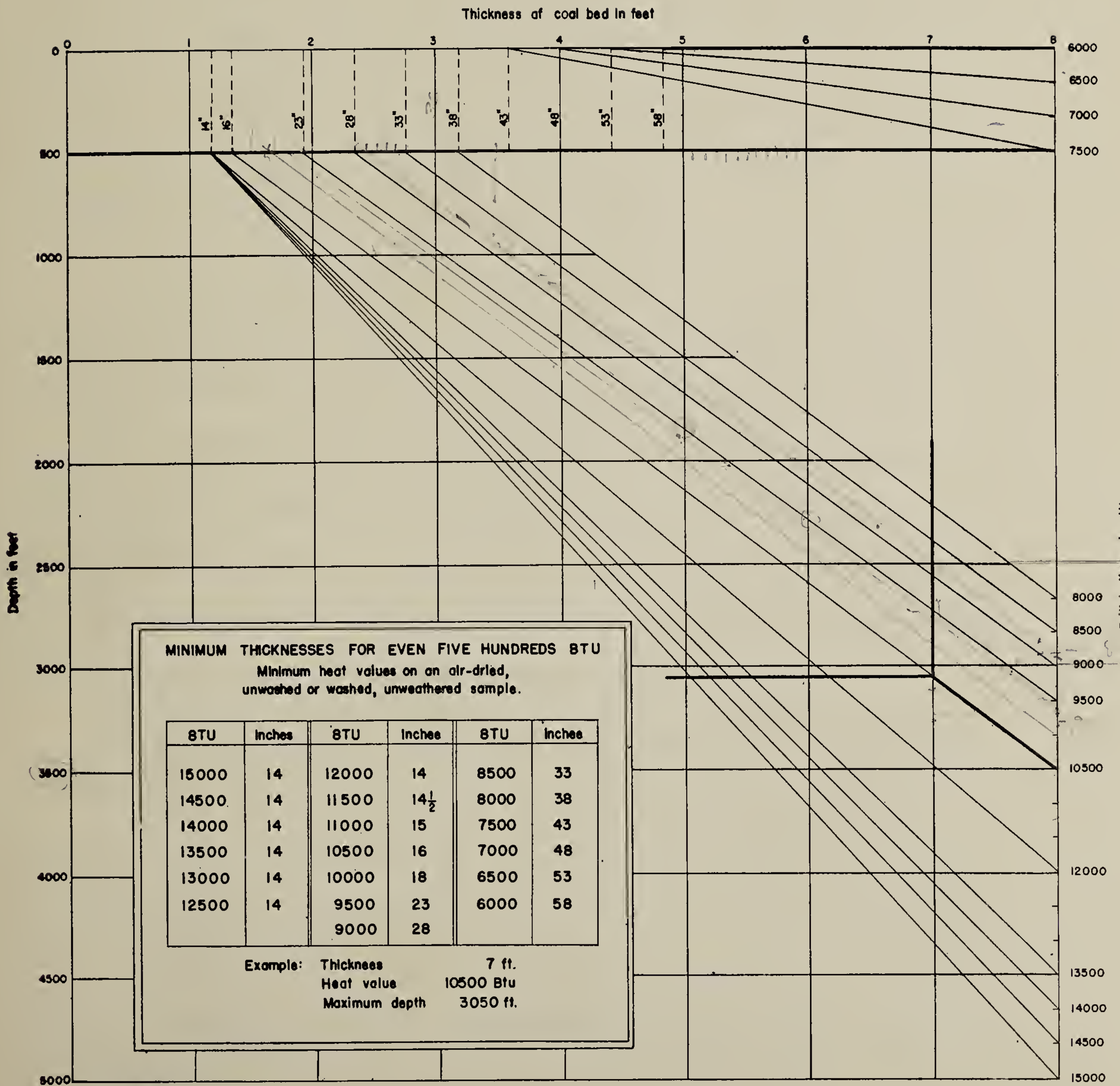
Minimum Thickness. -- A thickness of or equivalent to 14 inches is required for coals having a heat value of 12,000 Btu or more, increasing 1 inch for a decrease from 12,000 to 11,000 Btu; 1 inch for decrease from 11,000 to 10,500 Btu; 1 inch for each decrease of 250 Btu from 10,500 to 10,000 and 1 inch for each decrease of 100 Btu below 10,000. In computing thickness partings of less than 3/8 inch shall be omitted to determine the thickness of an individual bed. Beds and parts of beds made up of alternating thin layers of coal and partings shall be omitted if the partings make up more than half the total thickness.

Minimum Quality or Heat Value. -- A heat value of not less than 6,000 Btu on an air-dried, unwashed or washed, unweathered mine sample is required for coal of classifiable thickness and depth.

Depth Below the Surface Varying with Thickness and Heat Value:

(a) For classification purposes a minable depth of 5,000 feet is considered the maximum for any coal.

CLASSIFICATION CHART FOR COAL LANDS



MINIMUM THICKNESSES FOR EVEN FIVE HUNDREDS BTU

Minimum heat values on an air-dried, unwashed or washed, unweathered sample.

BTU	Inches	BTU	Inches	BTU	Inches
15000	14	12000	14	8500	33
14500	14	11500	$14\frac{1}{2}$	8000	38
14000	14	11000	15	7500	43
13500	14	10500	16	7000	48
13000	14	10000	18	6500	53
12500	14	9500	23	6000	58
		9000	28		

Example: Thickness 7 ft.
Heat value 10500 Btu
Maximum depth 3050 ft.

U.S. Department of the Interior
Geological Survey
Branch of Mineral Classification
1960

Figure 14

(b) For coals having heat values between 12,000 and 15,000 Btu and a minimum thickness of 14 inches the maximum depth shall be 500 feet.

(c) A depth increase below the surface for a bed of coal 8 feet or more thick having heat values between 8,000 and 15,000 Btu of not more than 100 feet for each 300 Btu or major fraction thereof; and for beds having these heat values, of any thickness between the minimum and 8 feet, a depth directly proportioned to the thickness shall be necessary to classify the lands as coal lands.

(d) If, however, the topography is such that part or all of the coal lies below the depth limit, but can be mined by means of an adit or tunnel, the land shall also be classified coal lands.

(e) The depth limit shall be computed for each individual bed except that where two or more beds occur in such relation that they may be mined from the surface opening. Under such conditions the depth limit may be determined on the group as a unit considering the partings or other impurities between successive beds.

(f) It is further provided that for coals having a heat value of 6,500 Btu and a thickness of 8 or more feet, the depth below the surface shall not exceed 167 feet; for coals with a heat value of 7,000 Btu and a thickness of 8 feet, the depth below the surface shall not exceed 333 feet; and for coals with a heat value of 7,500 Btu and a thickness of 8 feet, the depth below the surface shall not exceed 500 feet.

To be classifiable, a coal at or near the surface having a heat value of 6,000 Btu should have a thickness of not less than 58 inches;

a 6,500 Btu coal, a thickness of 53 inches at or near the surface; a 7,000 Btu coal, a thickness of 48 inches at or near the surface; and a 7,500 Btu coal, a thickness of 43 inches at or near the surface.

Classification by Legal Subdivisions. -- Classification shall be made by quarter-quarter sections, surveyed tracts or lots.

Review of Classification. -- Review of classification may be had only on application therefore to the Secretary, accompanied by a geologic map and a clear and specific statement of geologic conditions indicating that a change in existing classification of the land is warranted.

Availability of Minutes

The Minutes of the Coal Board approved by the Director September 9, 1959, contain additional details in support of these standards. Interested persons may consult these minutes, but publication in the Federal Register or Code of Federal Regulations will usually suffice for public notice of the classification standards in current use.

CLASSIFICATION OF OIL AND GAS LANDS

Criteria for Classification of Land as Oil and Gas Land

Land within a sedimentary basin or petroleum province shall be classified as valuable prospectively for oil and gas on the basis of several criteria; namely, thickness of sediments; evidence of oil and gas; and the presence, nature, and extent of folding and faulting.

Thickness. -- Areas known to have a sedimentary section of significant thickness are considered. This generally eliminates areas where original thickness of sedimentary rock is less that 1,000 feet, recognizing, however, that there are many productive sands that are found at depths less that 1,000 feet.

Maximum Depth. -- The lower depth limit of sediments is considered as 20,000 feet or more. This is based to some extent on the possible maximum drilling depth to an objective sand and the economic development of a productive sand.

Present Productive Areas. -- Present productive provinces are included. In addition to the areas defined by productive or formerly productive wells or fields, deeper undeveloped sands that may exist within the sedimentary basin are included, as well as stratigraphic traps and other untested structural traps. Included also are the known geologic structure of producing oil and gas fields. See (43 CFR, 192.6, 192,20 to 192.41).

Areas Omitted. -- Areas are omitted in which the information is too meager to warrant venturing an opinion on oil and gas possibilities. These are largely unmapped or untested areas, areas covered with thick layers of extrusives, alluvium, lacustrine deposits, or glacial debris.

Classification of Known Geologic Structures. -- The regulations governing the definition of producing oil and gas fields are given in 43 CFR, sec. 192.6.

Classification by Quarter-quarter Sections, Tracts, or Lots. -- Classifications shall be made by legal subdivisions, the smallest of which is the 40-acre subdivision or surveyed lots.

Review of Classification. -- Review of classification may be had only on application therefor to the Secretary, accompanied by a geologic map and a clear and specific statement of geologic conditions indicating that a change in the existing classification of the land is warranted.

Availability of Minutes

The Minutes of the Oil Board approved by the Director April 22, 1957, contain additional details in support of these standards. Interested persons may consult these minutes, but publication in the Federal Register or in the Code of Federal Regulations will usually suffice for public notice of the classification standards in current use.

CLASSIFICATION OF POTASH LANDS

Conditions Necessary for Classification of Land as Potash Land.

Land shall be classified as potash land if it contains potassium minerals that may be extracted from sedimentary deposits or from natural brines under the following conditions:

Bedded Deposits:

(a) Minimum thickness -- 4 feet.

(b) Minimum quality:

8% K_2O equivalent as sulphate ore.

14% K_2O equivalent as chloride ore.

(c) Maximum depth -- 5000 feet for ore of minimum quality and thickness.

Natural Brines. -- Brines in sufficient concentration and volume to warrant development, recovered from lakes or from wells not over 5,000 feet in depth, shall have a minimum content of potassium choloride (KCl) of not less that 4% by volume.

Classification by Legal Subdivisions, Surveyed Lots or Tracts. -- Classification shall be made by quarter-quarter sections, surveyed lots or tracts.

Review of Classification. -- Review of classification may be had only on application therefor to the Secretary, accompanied by a geologic map and a clear and specific statement of geologic conditions indicating that a change in existing classification of the land is warranted.

Availability of Minutes

The Minutes of the Potash Board approved August 10, 1957, contain additional details in support of these standards. Interested persons may consult these minutes but publication in the Federal Register or in the Code of Federal Regulations will usually suffice for public notice of the classification standards in current use.

CLASSIFICATION OF OIL SHALE LANDS

Conditions Necessary for Classification of Land as Oil Shale Land

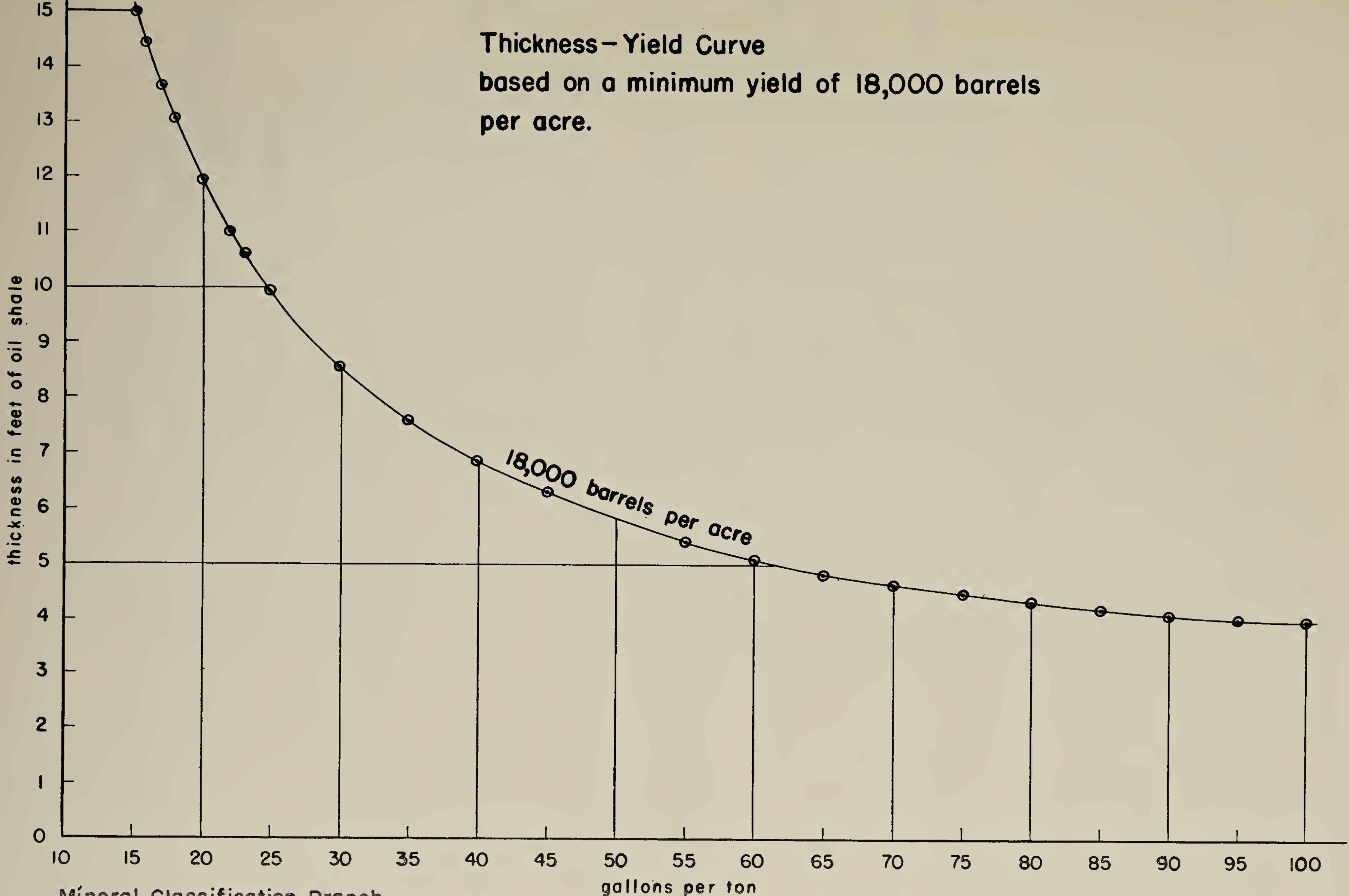
Land shall be classified as oil shale land if it contains a continuous sequence of beds yielding not less than 18,000 barrels per acre (17,678 bbls. computed) under the following limitations (see figure 15):

(a) Minimum thickness of 15 feet yielding not less than 15 gallons per ton, or

(b) Any thickness less than 15 feet fulfilling the minimum yield requirement of 18,000 barrels per acre.

(c) Maximum depth -- The depths below the surface of a 15-foot bed of 15-gallon shale shall not exceed 5,000 feet. For shale of less thickness but yielding the minimum of 18,000 barrels per acre, the depth shall be in direct proportion of that thickness to 15 feet.

OIL SHALE CLASSIFICATION CHART



Mineral Classification Branch

Figure 15

Classification by Legal Subdivisions. -- Classifications shall be made by quarter-quarter sections, surveyed lots, or tracts.

Review of Classifications. -- Review of classifications may be had only on application therefor to the Secretary; accompanied by a geologic map and a clear and specific statement of geologic conditions indicating that a change in existing classification of the lands is warranted.

Availability of Minutes

The Minutes of the Oil Shale Board approved March 8, 1957, contain additional details in support of these standards. Interested persons may consult these minutes, but publication in the Federal Register or in the Code of Federal Regulations will usually suffice for public notice of the classification standards in current use.

CLASSIFICATION OF PHOSPHATE LANDS

Conditions Necessary for Classification of Land as Phosphate Land

Western Fields

Land shall be classified as phosphate land under the following conditions (see figures 16 and 17):

Underground Mining:

(a) Thickness -- 3 feet or more.

(b) Quality -- 13.7 percent or more P_2O_5,30 percent B.P.L.

(c) Depth -- less than 5,000 feet below surface, except for accessible horizontal beds.

Opencut or Strip Mining:

(a) Thickness -- 1 foot or more.

(b) Quality -- 24 percent or more P_2O_5, (52.4 percent B.P.L.)

CLASSIFICATION CHART FOR WESTERN PHOSPHATES

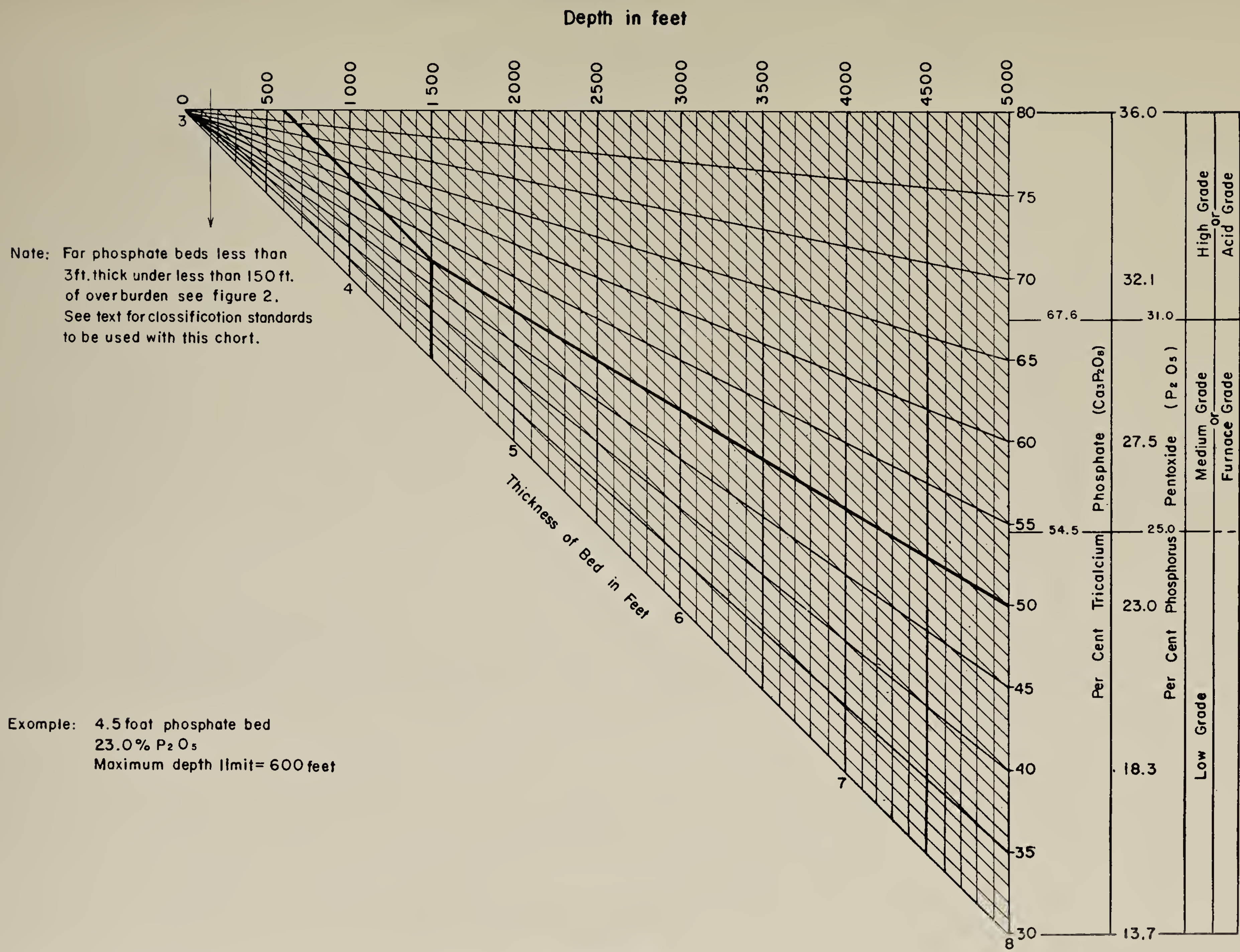
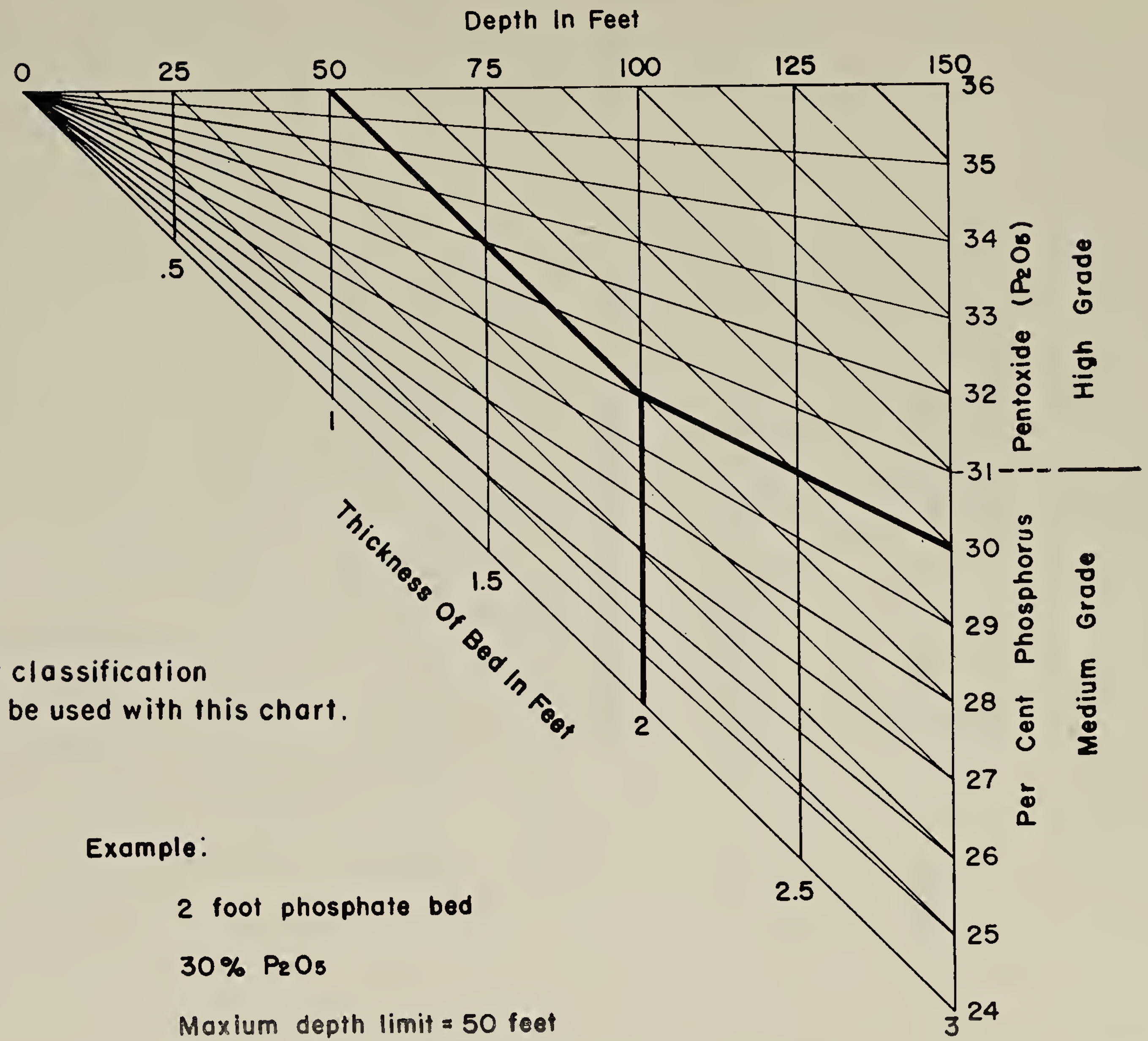


Figure 16

Classification Chart For Western Phosphates

Applicable to thin beds of medium and high grade under less than 150 ft. of cover



See text for classification standards to be used with this chart.

Example:

2 foot phosphate bed

30% P_2O_5

Maxium depth limit = 50 feet

Figure 17

(c) Depth -- 0 to 150 feet or more, ranging from the surface for 1 foot of 24 percent P_2O_5 or 52.4 percent B.P.L. to 150 feet for 36 percent P_2O_5 content or 80 percent B.P.L. or more.

Eastern Fields

Land shall be classified as phosphate land under the following conditions (see figure 18):

(a) Thickness -- 3 feet or more.

(b) Quality -- 4 percent or more P_2O_5 (recoverable); 9 percent or more B.P.L.

(c) Depth -- less than 150 feet below the surface.

(d) Content -- 50 long tons or more of P_2O_5 per acre-foot or 109 long tons of B.P.L. per acre-foot.

(e) Core holes -- 1 hole showing minimum quality or better per 40-acre tract or legal subdivision.

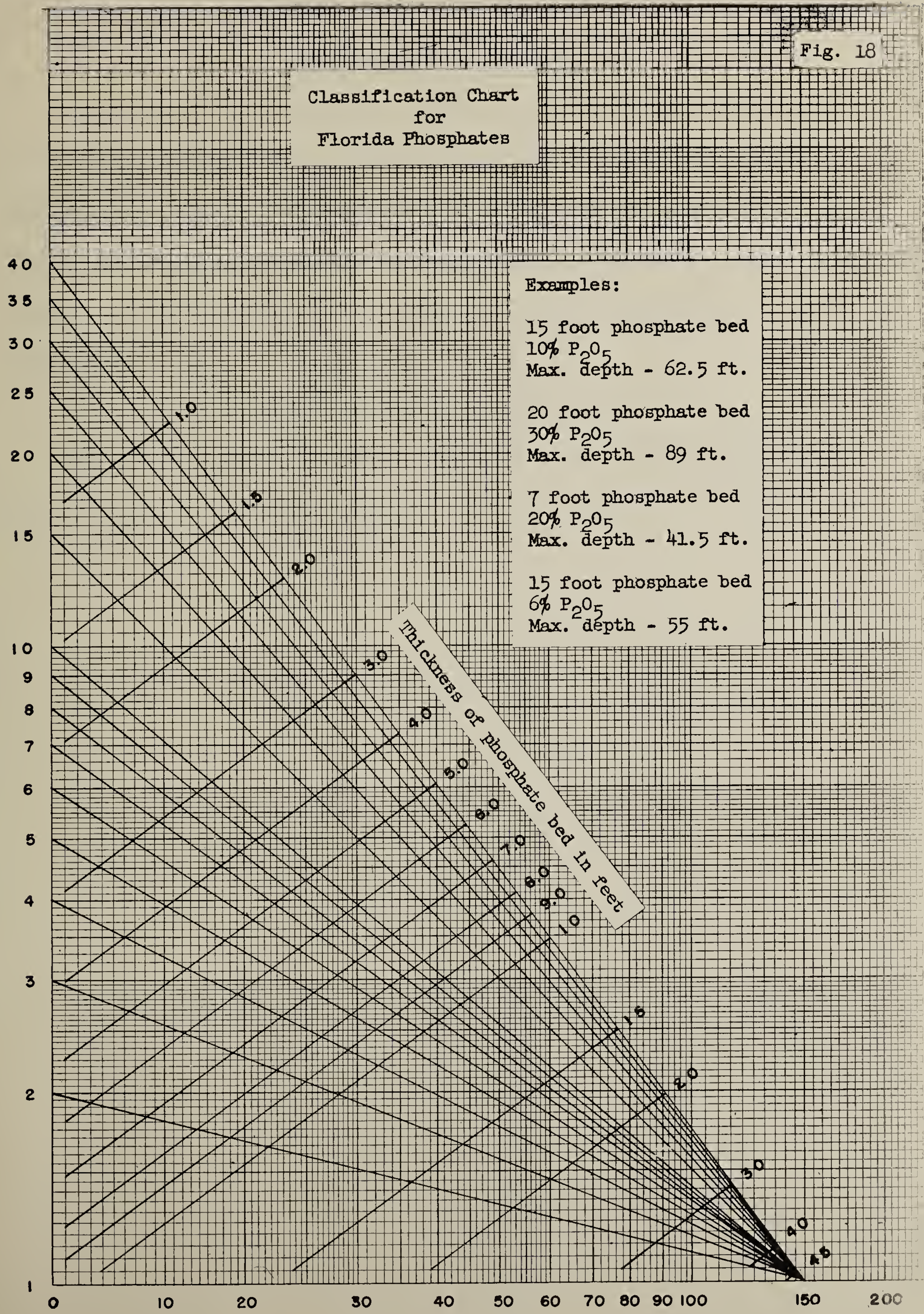
(f) Common edge with 40-acre tract or legal subdivision classified as phosphate land by reason of a core hole or other tests.

(g) Less than 5 percent total content of ferric oxide plus aluminum oxide.

Classification by Legal Subdivisions. -- Classifications shall be made by quarter-quarter sections, surveyed lots or tracts.

Review of Classification. -- Review of classification may be had only on application therefor to the Secretary, accompanied by a geologic map and a clear and specific statement of geologic conditions indicating that a change in existing classification of the land is warranted.

Fig. 18



April 1, 1959 Overburden in feet

Availability of Minutes

The Minutes of the Phosphate Board approved by the Director April 1, 1959, contain additional details in support of these standards. Interested persons may consult these minutes, but publication in the Federal Register or in the Code of Federal Regulations will suffice for public notice of the classification standards in current use.

CLASSIFICATION OF SODIUM LANDS

(Minutes of the Sodium Board containing proposed standards are being reviewed in Geologic Division -- June 1, 1960.)

BIBLIOGRAPHY
AND
APPENDIX

BIBLIOGRAPHY

Ashley, George H , and Fisher, Cassius A., 1910, The valuation of public coal lands: U. S. Geol. Survey Bull 424, 75 p.

Ball, Max W., 1917, Petroleum withdrawals and restorations affecting the public domain: U. S. Geol. Survey Bull. 623, 1917, 444 p. (Printed USGS Press Bull. 430, 1919, 8 p., and a mimeographed release, March 1, 1929, 16 p., bring the information up to the latter date.)

Birdseye, C. H., 1928, Topographic instructions of the U. S. Geological Survey: U. S. Geol. Survey Bull. 788, 432 p. (New manual of topographic instructions is being prepared in Books 1 to 6. These are being released in preliminary multilithed form, some of them in the form of circular publication, and these have superseded most of this older publication.)

Chief Geologist, U. S. Geol. Survey, Feb. 14, 1956, Geologic maps: classification, definition, and standards: Unpublished memorandum to all professional and supervisory personnel, 3 p. (official use only).

Cohen, Felix S., 1942, Handbook of Federal Indian law: Office of the Solicitor, Dept. of the Interior, 662 p.

Collier, A. J., and Knechtel, M. M., 1939, The coal resources of McCone County, Montana: U. S. Geol. Survey Bull. 905, 80 p.

Erdmann, C. E., 1950, Classification of reports in Minutes of Conference of Engineers, Water and Power Branch, U. S. Geol. Survey, Portland, Oregon, April 26, 27, 28, 1950: Unpublished, mimeographed, p. 16-17.

Feldner, A. C., and Selvig, W. A , 1938, Notes on the sampling and analysis of coal: U. S. Bur. of Mines Technical Paper 586, 48p.

Fuels Branch, U. S. Geol. Survey, 1950, Geologic map compilation: Unpublished Technical Workbook, 239 p. (mimeographed; official use only).

Geochemistry and Petrology Branch, U. S. Geol. Survey, 1956, Manual of laboratory services: 1st edition, unpublished, 49 p. (official use only).

Greene, Daniel M., 1931, Public land statutes of the United States: Washington, U. S. Govt. Printing Office, 855 p.

Interdivision Committee on Photogrammetric Techniques in Geology, 1956, Photogrammetric aids and compilation procedures for geologists: Unpublished exhibit book. (available at USGS libraries in Denver, Colo.; Menlo Park, Calif.; and Washington, D. C.)

Lawrence, F. F., Nordeen, C. E., and Pumphrey, H. L., 1957, History of land classification relating to waterpower and storage sites: U. S. Geol. Survey Circ. 400, 8 p.

Lewis, Elmer A., 1955, Oil land leasing act of 1920, with amendments and other laws relating to mineral lands: Washington, U. S Govt. Printing Office, 434 p.

Northrop, John D., 1941, The role of "known geologic structure" in leasing law administration: Unpublished paper presented at Fifth Conservation Division Conference, Tulsa, Oklahoma, March 27 - April 7, 1941.

Oilive, W. W., 1957, The Spotted Horse coalfield, Sheridan and Campbell Counties, Wyoming: U. S. Geol. Survey Bull. 1050, 83 p.

Pillmore, C. L., 1957, Application of high-order stereoscopic plotting instruments to photogeologic studies: U. S. Geol. Survey Bull. 1043-B, 34 p.

Rabbitt, John C., and Rabbitt, Mary C., 1954, The U. S. Geological Survey, 75 years of service to the Nation, 1879-1954: Science, v.119, p. 741 - 758.

Schopf, James M., 1950, Guide for the field description of coal beds: Unpublished U. S. Geol. Survey (Fuels Branch), mimeographed manuscript, revised, 20 p (Also see U. S. Geol. Survey Bull. 1111-B.)

Smith, George O., and others, 1913, The classification of the public lands: U. S. Geol. Survey Bull. 537, 197 p.

Snyder, N. H. (revised by Aresco, S. J.), 1957, Coal sampling: U. S. Bur. of Mines Tech. Paper 133, 16 p.

(U. S.) Bur. of Land Management, 1947, Manual of instructions for the survey of the public lands of the U S.: Bur of Land Management, Dept. of the Interior, 613 p.

______________________________, 1955, Information relative to the disposal and leasing of public lands in Alaska: Bur. of Land Management Inf. Bull. 2, 31 p.

______________________________, 1956a, The fundamental authorities for Federal land ownership and management: Unpublished, mimeographed, 46 p.

______________________________, 1956b, Mineral patents: Information relative to the procedure for obtaining patent to a mining claim: Unpublished, multilithed, 12 p.

(U. S.) Office of Federal Register, National Archives and Records Service, General Services Administration, 1954, Title 43 (Public lands: Interior), Code of Federal Regulations: Washington, U. S. Govt. Printing Office, 786 p. (plus annual Cumulative Pocket Supplement).

________________________, 1959, Title 30 (Mineral resources), Code of Federal Regulations: Washington, U. S. Govt. Printing Office, 631 p. (plus annual Cumulative Pocket Supplement).

(U. S.) The President, 1948, Executive Order 10006--Preparation, presentation, filing, and publication of Executive Orders and Proclamations: Federal Register, v. 13, p. 199, October 12, 1948.

________________________, 1952, Executive Order 10355--Delegating to the Secretary of the Interior the Authority of the President to withdraw or reserve lands of the U. S. for public purposes: Federal Register, v. 17, p. 195, May 28, 1952. (See also Title I, Code of Federal Regulations, General Provisions, Chap. 1, Administrative Committee of the Federal Register.)

APPENDIX

A. -- Procedure for collecting channel samples of coal for analyses or tests performed by the Bureau of Mines

1. Select a fresh face of unweathered coal normal to the dip Do not collect the sample from a natural outcrop, or from a place where the coal has been long exposed to the atmosphere.

2. Clean the surface of all powder stains and other impurities.

3. Spread a piece of oilcloth or rubber cloth on the floor so as to catch the particles of coal as they are cut, and to keep out impurities and excess moisture where the floor is wet. Such a cloth should be at least $1\frac{1}{2}$ by 2 yards in size, and should be spread so as to catch all the material composing the sample.

4. Cut a channel perpendicularly across the face of the coal bed from roof to floor, with the exceptions noted in paragraph 5, of such size as to yield at least 6 pounds of coal per foot of thickness of coal bed; that is, 6 pounds of sample for a bed 1 foot thick, 12 pounds for a bed 2 feet thick, 18 pounds for a bed 3 feet thick, etc.

5. All material encountered in such a cut should be included in the sample, except partings or binders more than three-eighths inch in thickness, and lenses or concretions of "sulphur" or other impurities greater than 2 inches maximum diameter, and one-half inch in thickness.

6. The coal should be pulverized and quartered down immediately after being cut, and inside the mine if possible, in order to avoid changes in moisture, which take place rapidly when fine coal is exposed to different atmospheric conditions. The coal should be pulverized until it will pass through a sieve with one-half inch mesh, and then, after thorough mixing, it should be divided into quarters, and opposite quarters rejected. The operation of mixing and quartering should be repeated until the sample is reduced in size for convenient handling. When the work is properly done a quart sample, about 3 pounds is sufficient to send in for chemical analysis. This sample should be sealed in either a glass jar or a screw top can with adhesive tape over the joint. The Bureau of Mines will provide special cans for this purpose on request, and these should be used wherever possible. Instructions for obtaining these cans are given below.

7. A detailed section of the coal and adjoining rocks should be measured at the point sampled, and the Bureau of Mines sample cards, A and B, should be filled out at the same time according to the instructions thereon.

8. The coal samples and the cards should be sent direct to Coal Analysis Section, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pa., with a covering letter describing the shipment and specifying the type of analysis desired. A proximate analysis should be requested for all normal channel samples. The proximate determinations include moisture, volatile matter, ash, and fixed carbon. Sulfur and B.t.u. determinations also should be requested on samples for coal classification. Specific gravity, apparent or real, or both, also may be requested. In the critical range, where it is difficult to distinguish bituminous from subbituminous coal, agglutinating values should be requested. If further question remains it may be necessary to resample for an additional weathering test.

The ultimate analysis includes carbon, hydrogen, oxygen, nitrogen, sulfur, and ash determinations. Ultimate analyses are of lesser value for coal classification in America and are much more difficult and costly to perform. They should not be requested unless sampling directions have been meticulously followed and there is real need for this information. In any coal field a few good ultimate analyses suffice for a general comparison with foreign coals which are more generally classified from this type of data.

9. Coal sample cans and cards mentioned in paragraph 7 above, can be obtained by writing to Sup't. Pittsburgh Station, U. S. Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pa., and explaining the purpose to which they will be put. -- Extract from Schopf, 1950.

B. -- Check list for field description of coal beds [1]

A. Locality to nearest 1/16 of a section where land plats are available; if no plat available distance by odometer from a definite point, road name and direction.

B. Bed name, if known; otherwise, estimate distance above or below some identifiable stratigraphic datum; locate in geologic member or formation.

C. Name of property owner or mine operator if this information may assist some one else in identifying the particular locality.

D. Conditions for observation (clear obs.; semi-obscure obs.; obscure obs.).

E. Commercial variety of coal (common-banded, non-banded, mixed).

F. Description of coal bed:

1. Measurement profile (subdivision of bed according to lithologic character of layers, partings, impurities, etc.) Record top, bottom, and all layer and parting boundary measurements in feet and inches in skeleton form, leaving space for intercalation of all layer and parting descriptions called for in 2.

2. Description of layers:

Semi-quantitative estimation of ingredients.

a. Vitrain (in coals of higher rank than lignite; brilliant, vitreous bands)

Pre-vitrain (in lignite where woody bands lack vitreous luster)

Thickness classes	Frequency classes
Thin bands.....$\frac{1}{2}$ to 2 mm	Sparse.....less than 15%
Medium bands...2 to 5 mm	Moderate...15 to 30%
Thick bands....5 to 50 mm	Abundant...30 to 60%
Very thick bands........over 50 mm	Dominant...more than 60%

b. Fusain (charcoal-like, dull luster)
Estimate according to thickness and frequency of bands for vitrain, but indicate all fusain notes as "F".

c. Attrital coal (the micro-fragmental matrix of banded coals; also includes all of non-banded coals)
Describe as to (1) Luster (bright, moderately bright, medium, moderately dull, dull), (2) Surface (earthy, rough, granular, silky, etc.)

Notes on impure coal layers and partings. Describe using geologic terms; determine whether hard or soft in mining; miners' terms to be used only for indentification.

Notes on cleating or jointing (optional for individual layers). Describe as to (1) Frequency and prominence, (2) Orientation determine (compass bearing of cleat planes.)

Notes on mineral occurrences (optional for individual layers). Describe occurrence of common minerals (kaolinite, calcite, pyrites, etc.)

G. Rock strata adjacent to the coal bed.

1. Roof; give any descriptive details supplemental to standard notes on geologic section that may have importance for mining.

2. Floor; same as for roof (do not use "fireclay" unless the clay is known to be refractory).

1/ Extract from Schopf, 1950. This is a sample guide for a rather complete scientific treatise, and detail as listed in paragraph F-2, especially, is not expected of geologists in the Branch of Mineral Classification; but most of the information indicated in paragraphs A, B, C, D, E, F-1, and G is desirable.

Hayden

Branch of Mineral Classification
Handbook of Instructions

Transmittal Sheet

Release No. 1 November 20, 1961

EXPLANATION OF MATERIAL TRANSMITTED

The accompanying release is a discussion of the subject of "Principles governing Mineral Land Classification" extracted from the Minutes of the Metalliferous Board dated April 17, 1912, and was written by F. C. Calkins. Because of the applicability of these principles to land classification in general and to any metalliferous classification that our geologists may be called upon to do in the future, it is believed you will find this discussion of great value. This attachment should be considered in connection with Chapter 5.

J. C. Miller

FILING INSTRUCTIONS

Add to Appendix

Distribution:

All geologists of Branch

(Extracts from Minutes of Metalliferous Board
Refers to minerals other than coal or phosphate)

PRINCIPLES GOVERNING MINERAL LAND CLASSIFICATION

THE PROBLEM

by F. C. Calkins
April 17, 1912

Legal Principles

From a summary of laws and decisions prepared by Mr. A. R. Schultz and others, it appeared that classification had been made in the past on two different principles, namely:

1. Land is to be classified as mineral which is chiefly valuable for mineral deposits.

2. Land is to be classified as mineral which contains or on account of its geological conditions is believed (likely) to contain mineral deposits capable of profitable development.

It was the consensus of opinion that the second principle rather than the first expressed the purpose of the laws. These appear to have been intended for the encouragement of the prospector, and the opinion of those called upon to execute the law regarding its wisdom should not influence their action.

The problem, then, to be determined by one detailed to classify a tract of land mineral or nonmineral is:

What parts of the tract in question contain mineral deposits that can be profitably developed?

APPLICATION

The foregoing sentence embodies, perhaps, as full a statement of the problem as may be drawn from the letter of the law; but it is obviously too general to serve as a complete guide in practice, and difficulties in its application to concrete cases may readily be imagined, for example:

1. Upon whom does the burden of proof rest? Should doubts be resolved in favor of the Government side in every dispute? May it not be held that in land-grant cases (Northern Pacific) positive reason should be shown for excepting lands from the general terms of the grant?

2. Does "valuable" mean valuable under actual conditions or under future conditions? Those participating in the discussion showed an inclination to consider present value as determinative; but the point is perhaps open to further question. What of lands, which by reason of inaccessability, are at the present time virtually without value for any purpose? Again, can a deposit be considered valueless which would be valuable under conditions to be expected to exist in the future? Is not such a deposit "valuable", though perhaps to a slight degree? The crucial test, perhaps, would be the market price of the land containing it, supposing its use for the purposes other than mining could be pre-empted.

3. The question of greatest interest to the examiner is perhaps this: How precise and thorough is it reasonable to expect that the classification shall be? The strictest possible fulfillment of legal requirements would imply positive proof of the existence or non-existence of valuable deposits on each 40-acre tract in question. But no geologist will hold that such proof is always obtainable. Even if it were possible, as it never is in fact, to command unlimited time and money, and the services of the most highly qualified experts, classification of a large tract can hardly be free from some errors of detail. The classification can, at most, only embody the least available judgement.

Now it is obvious that judgement must be far more fallible under some circumstances than under others. No tract containing metalliferous minerals can be evaluated with the same degree of certainty as coal and phosphate lands of single structure; but classification is easier, for example, where the veins are comparatively uniform in trend and tenor than where there is great irregularity with respect to these features. The accuracy with which land can be classified depends in still greater degree upon the accessibility with which it has been prospected, the thoroughness, and upon the extent to which its rocks are exposed. ....

Means of Solving

THE PROBLEM

Kinds of Evidence Available

The evidence upon which the classification must be based falls into two classes:

1. That supplied by the geology;

2. That supplied by prospects and mines, and also by assays of material collected by the examiner.

Both kinds of evidence are partly negative, partly positive, but the negative quality rather preponderates in the first kind, and the positive in the second; in other words, it is difficult to prove by the evidence of prospects that it is not mineral.

GEOLOGIC EVIDENCE

Country Rock

Experience indicates that some kinds of country rock are more likely than others to contain valuable deposits. The extent and cause of the influence of country rock are different in different cases; and in general the favorable or unfavorable character of the rock may be due to chemical or to physical causes. ....

INTRUSIONS

Although the degree to which ore-deposition depends on an intrusion is a moot point, it is a well-established induction that ore-deposits are more abundant in regions where intrusions are abundant than in those where intrusions are absent. Ore deposits remote from intrusions exist (the lead and zinc deposits of the Mississippi Basin, for example) but they are exceptional. The presence of intrusions must then be considered favorable to the deposition of ores. The distribution of ore deposits and of intrusions is related, however, only in a somewhat general way. In ore-bearing districts, the distribution of the ores is broader than that of distinct metamorphism. ....

STRUCTURE

Generally speaking, rocks that have been much deformed are more likely to contain valuable metalliferous minerals than rocks that have been little deformed. There are two reasons for this:

1. Fissures are more likely to exist in deformed rocks, particularly if they have been faulted.

2. Deformation is likely to be associated with igneous intrusion and other activities related to ore-deposition.

.... Faulting is more favorable than folding, and normal faulting probably more favorable than thrust faulting inasmuch as it tends to the formation of open fissures rather than closely compressed ones.

VEIN OUTCROPS AND FLOAT

Vein-outcrops constitute the most direct evidence of mineral value that can be observed on the field apart from actual development........

Size, persistence, and composition are other features to be noted. ....

Float must be regarded as secondary in importance to veins found in place, for the locality from which it comes is uncertain and it affords no definite evidence regarding other features than composition. ....

Gossan capping veins of easily decomposed material may constitute important evidence; it is more likely, perhaps, to escape observation than quartz veins, and should consequently be looked for with more especial attention.

COMPARISON WITH NEIGHBORING REGIONS

As already remarked, no rules that can be laid down constitute an infallible guide; for conditions in two districts may be as nearly alike as it is practicable to determine, yet one may prove productive, and the other barren. This, however, is more likely to be true if the two districts are far apart than if they are near together; for in the one case they are likely, in the other unlikely, to be in the same metallographic province. ....

PROSPECTS AND MINES

Since mining location and potential claims are considered as prima facie evidence of mineral character, all possible claim posts and prospects should be noted, and records of patented claims obtained from the General Land Office. Prospects should also be examined with a view not only to determining their value, but also of obtaining evidence applicable to surrounding lands. ....

SAMPLING AND ASSAYING

The most definite evidence that the examiner can obtain, and that which will, perhaps, have the greatest weight at a hearing, is supplied by assays. Much reliance may be placed by those contesting a mineral classification, upon samples carefully taken where they are unlikely to have any value. Such evidence, however worthless in fact, will have its effect if unopposed; but it is disposed of very thoroughly if a respectable number of good assays can be produced. The examiner, therefore, can hardly take too many samples. ....

RECORDS AND REPORTS

Maps and reports covering areas classified are required for the records of the Land Office and for exhibition at hearings. These should embody the evidence upon which the classification is based in the clearest and most effective form. .... The data, other than topographic, shown on the maps should comprise those that are ordinarily shown on folio sheets and the following in addition:

1. All land corners found.

2. If the traverse method is used, the course of the traverse.

3. Outcrops of breccia and vein material, with this direction indicated, if possible.

4. Occurrences of disseminated minerals that either are valuable themselves or likely to be associated with valuable minerals. .....

5. Whether exposures are abundant, scarce, or absent.

6. Assay figures, preferably on the map at the points where the specimens assayed were taken.

Photographs of vein outcrops or other features of interest in connection with the classification should be submitted.

* * * * *

The foregoing was reviewed by Lindgren, Mendenhall, Ball, Bastin, Lesher, McCoskey, Schultz, Pardee, and Stone. According to F. C. Calkins, "This sketch is not intended as a draft of instructions to examiners of such lands, but rather as a basis of a discussion. With the help of suggestions thus evoked, a set of instructions in more concise and positive terms will be formulated. These may perhaps be combined with the instructions in regard to matters of form that are being prepared by Mr. Ball."

Branch of Mineral Classification
Handbook of Instructions

Transmittal Sheet

Release No. 2 November 20, 1961

EXPLANATION OF MATERIAL TRANSMITTED

This release consists of two extracts from the Minutes of the Metalliferous Board dated March 29, 1912, and April 24, 1912. These statements are important in that they established certain guidelines for land classification based on the law or interpretations of the law particularly as related to nonmineral land entries. These statements should be considered in connection with Chapter 5.

J. C. Miller

FILING INSTRUCTIONS

Add to Appendix

Distribution:

All geologists of Branch

Extracts from
Minutes of the Metalliferous Board
March 29, 1912

Congress in the Act of February 26, 1895 (28 Stat. 683) Sec. 3 (Northern Pacific Railroad lands) furnishes a safe and appropriate guide for future classification work: that is, it must be determined before the lands are withheld from patent to the Northern Pacific Railroad that there is a reasonable probability that they contain valuable mineral deposits. "The Act did not require actual discovery of mineral on a tract classified as mineral land on evidence which is not sufficient basis for issuance of mineral patent." (Finney) Survey might make its classifications .... upon the basis of the reasonable probability of the land containing valuable mineral deposits.

Max Ball believed that the principles of relative worth (comparing it to agricultural or timber land use) has become fixed in land practice. G. Otis Smith expressed the opinion that Ball's opinion regarding ultimate relative value is that it is ideal but not based on law.

Mr. Mendenhall: "Are we not pretty generally agreed that in our work under the general laws we shall consider only whether or not there is an actual or prospective value and not consider relative values. We reserve the right to consider relative values where these enter.

April 24, 1912. Notes on Minutes of the Metalliferous Board of March 29, 1912:

"The whole question of value for the purpose of land classification, in my judgement, resolves itself in the question whether land is or is not of sufficient apparent and prospective mineral value to warrant the serious and bona fide expenditure of time and labor in the hope of developing a profitable mine or quarry.

"In the absence of either class of evidence .... [direct or indirect (geological)] attempt at classification should obviously be postponed. With sufficient geological evidence, and in the absence of direct evidence, it would seem that land might be tentatively classed as mineral; but in the absence of direct evidence particular caution should be used in clearlisting land as nonmineral. The distinction is thought to be justified by the fact that lands clearlisted pass beyond possibility of further Government classification."

Branch of Mineral Classification
Handbook of Instructions

Transmittal Sheet

Release No. 3 — November 20, 1961

EXPLANATION OF MATERIAL TRANSMITTED

The accompanying release is an explanation of current policy regarding nonofficial expressions in the form of speeches, lectures, and books, or by any other oral or visual methods. This attachment should be considered as modifying and enlarging the paragraph on "Speeches".

J. C. Miller

FILING INSTRUCTIONS

Remove Old Sheet		Insert New Sheets	
Chapter	Sheet	Chapter	Sheet
VI	180	VI	180-180a

Distribution:

All geologists of Branch